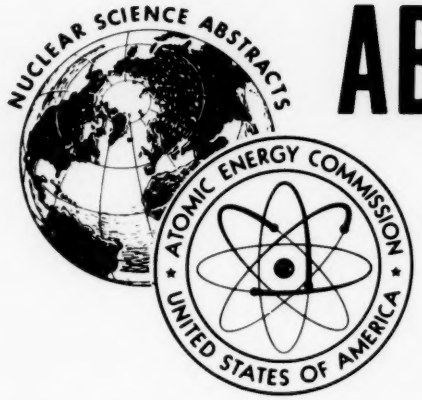
NUCLEAR SCIENCE ABSTRACTS



Volume 26 Number 22

Abstracts 52893-55642

November 30, 1972

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Volume 26, Number 22, November 30, 1972

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```
NEWCOMB, William A., Stability of a magnetic well,  25:1239
NEWKIRK, L. R., Superconductivity in the pseudobinary
   alloys V3Si--Nb3Al,  25:1093 (CALT-822-13)
NEWLAND, E. A., Radiation treatment of sewage,  25:140
   (AAEC/LIB/81b-254)
```

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```
TRANSURANIUM ELEMENTS
  determination in bone ash, radiochemical method for,
    25:40 (IDO-12073, pp 28-36)
  separation by ion exchange and complex-formation elution,
    25:251(P)
TRIETHYLENETETRAMINE
  complexes with cobalt(III) and rhodium(III) chlorides,
    radiation effects on labeled, thermal-neutron,  25:137
TRITIUM
  content in Cattaraugus Creek near West Valley Processing
    Plant, July through Dec. 1969,  25:258 (DOCKET-50201-
    48)
  content in Cattaraugus Creek near West Valley Processing
    Plant, Jan. to July 1970,  25:259 (DOCKET-50201-49)
  determination in luminescent material by scintillation
    counting,  25:40 (IDO-12073, pp 28-36)
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Technical report literature is indexed from the name of the organization or institution responsible for the issuance of the report.

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is indexed as:

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CALIFORNIA UNIV., LIVERMORE.  LAWRENCE RADIATION LAB.
  Construction of a unique underground whole body counter,
    25:372 (UCRL-72739)
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  30(Pt.2)    25-331    Dep. NTIS

ORNL-NSIC-
  78          25-1912   Dep. NTIS
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NUCLEAR SCIENCE ABSTRACTS

CHEMISTRY

52893 (EUR-4765) 2nd CONFERENCE ON MASS SPECTROMETRY, ISPRA, ITALY, 1-3 SEPTEMBER 1971. Facchetti, Sergio (comp.) (European Atomic Energy Community, Luxembourg. Center for Information and Documentation). Nov 1971. 485p. (In several languages). (CONF-710957).

Separate abstracts were prepared for 7 of the 26 papers included. The remaining 19 papers are outside the scope of NSA. (J.W.R.)

For abstracts of individual papers see: 52916-52918, 52982, 53033, 53549, and 54495.

Analytical Chemistry

Refer also to abstracts 53027, 53109, 53211, 53287, and 53330.

Activation and Nuclear Reaction Procedures

Refer also to abstracts 53121, 53212, and 53217.

52894 (CEA-R-4338) MANUFACTURE AND ANALYSIS OF SINGLE CRYSTALS OF LABELED LITHIUM HYDRIDE. Guerin, Danielle; Lefevre, Hubert (Commissariat a l'Energie Atomique, Bruyeres-le-Chatel (France). Centre d'Etudes). Jun 1972. 34p. (In French). Dep. NTIS (U. S. Sales Only).

The homogeneity of lithium hydride single crystals produced by hydrogen and lithium synthesis was investigated. The effect of freezing on the segregation of impurities was studied. Two testing methods were used: the introduction of radioactive tracers in fused Li, and the activation analysis of impurities. (France)

52895 (CONF-710959-, Paper 18) BEHAVIOUR OF FISSION AND CORROSION PRODUCTS IN SODIUM. Davies, R. A. 9p.

From Meeting on fission and corrosion product behaviour in primary systems of LMFBR's; Bensberg, Germany (20 Sep 1971).

A method for studying the solubility of elements in liquid sodium is described. A known amount of neutron activated solute in a capsule containing liquid sodium is monitored. The amount of solute actually in solution is determined by comparing the activity of the solute in the region of an absolute with that in the rest of the capsule. (J.M.J.)

52896 (CONF-720920-2) RELIABILITY IN SCIENTIFIC EVIDENCE BASED ON MULTI-TRACE FORENSIC NAA. Lyon, W. S.; Ricci, E.; Bate, L. C.; Dyer, F. F. (Oak Ridge National Lab., Tenn.). 1972. 9p. Dep. NTIS.

From 2nd international conference on forensic activation analysis; Glasgow, Scotland (27 Sep 1972).

Neutron activation analysis has been accepted in the courts and successfully used in a number of trials. Some individualistic solutions (such as hair) that once appeared to offer an easy road to criminal identification and prosecution are now viewed more realistically. It is in these areas that more care must be taken. Biological material, such as blood and hair, and many inhomogeneous organic-inorganic mixtures, such as soil, may never be amenable to complete identification by neutron activation. (auth)

52897 (CONF-721010-3) ANALYSIS OF TRACES AT ORNL'S NEW HIGH-FLUX NEUTRON ACTIVATION LABORATORY. Ricci, Enzo; Handley, T. H.; Dyer, F. F. (Oak Ridge National Lab., Tenn.). 1972. 11p. Dep. NTIS.

From International conference on modern trends in activation analysis; Saclay, France (2 Oct 1972).

A facility for neutron activation analysis (NAA) with a thermal flux of 5×10^{14} cm^{-2} sec^{-1} was recently installed at the ORNL High Flux Isotope Reactor. This unusually high flux together with a small computer and necessary software for γ spectrometry with a Ge(Li) detector makes possible shorter irradiation, faster data analysis, and more economical analysis than is possible using more conventional facilities. Features and tests of the High-Flux NAA Laboratory are discussed, as well as results of comparator and absolute NAA of several types of environmental matrices for mercury, cadmium, bromine, arsenic, chlorine, and sodium. (auth)

52898 (COO-3034-2) APPLICATION OF NUCLEAR TECHNOLOGY TO ART IDENTIFICATION PROBLEMS. Final Report. Keisch, Bernard; Miller, Holly H. (Mellon Inst., Pittsburgh, Pa.). Feb 1972. Contract AT(11-1)-3034. 89p. Dep. NTIS.

Neutron activation analyses of lapis lazuli, Italian renaissance bronze objects, and various samples of terracotta statuary are described. The limited utility of this method for purposes of identification of these materials is described. A simple procedure for determining ^{14}C context of cellulosic materials is described that can be used to detect man-made additions since the 1950's. The application of Mössbauer effect spectrometry to analytical problems of the fine arts is introduced and the potentialities of the method are explored. A brief summary of general conclusions reached regarding the use of various nuclear methods explored during the four-year research period is presented. (auth)

52899 (LA-DC-72-809) ACTIVE ^{3}He ACTIVATION ANALYSIS FOR CARBON AND OXYGEN. Sanders, Wm. Mort; Barnes, Barry K.; Holm, Dale M. (Los Alamos Scientific Lab., N. Mex.). 1970. 17p. (CONF-721010-2). Dep. NTIS.

From International conference on modern trends in activation analysis; Saclay, France (2 Oct 1972).

The surface and body concentrations of carbon and oxygen were measured in various materials using prompt ^{3}He activation techniques. Thin target excitation functions were determined for (^{3}He,p) reactions with carbon and oxygen over a ^{3}He energy range from 2.5 to 9.0 MeV. These data were used in the calculations of activation curves for various combinations of incident particle energy, impurity distributions, and material. Information on a computer code that was used in the analysis of the data is presented. (auth)

52900 (LYCEN-7236) ANALYSIS OF THIN LAYERS OF CHALCOGENIDE GLASSES FOR Te, As, Ge, AND S, USE OF THE NUCLEAR REACTIONS AND X RAYS PRODUCED BY PROTON BOMBARDMENT. Porte, Louis (Lyon Univ. (France). Institut de Physique Nucleaire). Jun 1972. 59p. (In French). Dep. NTIS (U. S. Sales Only). Thesis.

The quantitative analysis of thin layers of chalcogenide glasses for As, Ge, S, and Te was studied. Two methods were used, the first based on nuclear reactions resulting from proton bombardment of the sample. Experimental parameters for the analysis are given. X-ray fluorescence analysis was also used. The two methods gave comparable results with good precision. (J.G.B.)

52901 (UJV-2851-F,Ch) NONDESTRUCTIVE NEUTRON ACTIVATION ANALYSIS OF MINERAL MATERIALS. II. Benada, J.; Randa, Z.; Kuncir, J.; Vobecky, M. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). Jun 1972. 88p. Dep. NTIS (U. S. Sales Only).

The gamma spectra of 9 further elements that can be found in INAA (instrumental neutron activation analysis) of mineral materials and 41 mineral materials are included. These gamma spectra were measured after at least 9 hours cooling time. Besides these spectra of artificial radionuclides, the products of a neutron activation, gamma spectra of the natural decay products of uranium and thorium are included together with a typical background spectrum. (auth)

52902 ANALYSIS OF THIN ALUMINA FILMS OBTAINED BY REACTIVE SPUTTERING: NUCLEAR REACTIONS; I.R.; ELECTRON DIFFRACTION. Diaine, C.; Roger, J. A.; Pivot, J.; Cachard, A.; Dupuy, C. H. S. (Univ. Lyon, Villeurbanne, France). pp 377-84 of International Colloquium on the Application of Vacuum Techniques to the Semiconductor Industry, Electronic, and Microelectronic Components. Paris; Societe Francaise des Ingenieurs et Techniciens du Vide (1971). (In French).

From a third international symposium on the application of vacuum techniques in semiconductor industry, electronic components, and microelectronics; Versailles, France (13 Sep 1971). See CONF-716932.

Microanalysis using simultaneously (d,p_0) nuclear reactions with ^{16}O and [illegible] and infrared spectrophotometry enabled the composition of aluminum oxide obtained by reactive sputtering in oxygen to be determined. The dependence of the composition on the energy conditions in the discharge was studied. The stoichiometric properties of the alumina obtained were shown to be dependent upon the sputtering voltage, high voltages being necessary to obtain a good stoichiometry. Comparisons with the electric properties enabled the results obtained to be generalized for SiO_x, the presence of a negative differential resistance (dV/dI) being related to an excess of oxygen in the oxide. (France)

52903 RADIOANALYTICAL PURIFICATION OF PROTACTINIUM BY ANION EXCHANGE IN HYDROCHLORIC ACID–HYDROFLUORIC ACID MEDIUM. Dominguez, G.; Adrada, J. (Junta de Energia Nuclear, Madrid). An. Quim.; 67: No. 6, 591-606(1971). (In Spanish).

To establish the possibility of separating Pa from interfering elements in solution resulting from the HNO_3–HF–H_2SO_4 attack on neutron-irradiated ores, in connection with the activation analysis for Th, the distribution coefficients of Pa, Ac, Nb, and Np in Dowex 1 resins and HCl (12 to 9N)–HF (0.003 to 1N) mixtures were determined. The separation of these elements seems to be possible; Zr and Ru interfere, but H_2SO_4 and Fe(III) can be tolerated. (Anal. Abstr.).

52904 ROUTINE DETERMINATIONS OF TRACES OF COBALT IN SOIL AND PLANT TISSUE BY INSTRUMENTAL NEUTRON ACTIVATION ANALYSIS. Johansen, O.; Steinnes, E. (Institutt for Atomenergi, Kjeller, Norway). Acta Agr. Scand.; 22: No. 2, 103-6(1972).

The determination of cobalt in soils and vegetable tissue using instrumental neutron activation analysis with a well-type NaI(Tl) detector was studied. The amount of work per sample is low, and the sensitivity is adequate for direct determination in plant samples. The precision of the method in routine application is of the order of 5%. (auth)

52905 ACTIVATION ANALYSIS FOR VANADIUM IN MINERAL OIL. Mayer, Walter A. Erdoel Kohle, Erdgas, Petrochem.; 24: No. 6, 416-17(1971). (In German).

The sample (as received or diluted with xylene) in a Zircaloy tube is irradiated for 10 min. in a neutron flux of $\simeq 3 \times 10^8$ neutrons/sq. cm/sec., then transferred to a glass container, and, 1 min. after irradiation, the γ-ray activity of the induced ^{52}V is counted for 10 min. at 1.43 MeV with a NaI(Tl) scintillation counter. Interference by the 1.6-MeV peak of ^{38}Cl produced from natural Cl in the oil is corrected by making a second 10-min. measurement 17 min. after the end of irradiation. If the counts accumulated in the second measurement are multiplied by 1.373 and subtracted from the value obtained in the first measurement, the corrected activity corresponds to the ^{52}V. Standards containing 0.1, 1, and 10 ppM of V are analyzed analogously. The detection limit is 0.02 ppM of V in the oil, and, at the 1-ppM level, the accuracy is within $\simeq 2\%$. (Anal. Abstr.)

52906 NEUTRON ACTIVATION OF SILVER, CADMIUM, INDIUM, TIN, ANTIMONY, TELLURIUM, AND IODINE: ANALYSIS OF METEORITIC, TERRESTRIAL, AND LUNAR MATERIALS. Elzie, Johnny Lee. Los Angeles; Univ. of California (1972). 135p. University Microfilms Order No. 72-22,162.

Thesis.

Silver, cadmium, indium, tin, antimony, tellurium, and iodine were determined in separated meteoritic phases and terrestrial materials by neutron activation analysis. Cadmium and indium were determined in lunar materials returned by Apollo 12 and Apollo 14. The elemental separation scheme involved the separation and purification of iodine by repeated extractions into carbon tetrachloride. Tellurium was determined via ^{131}I in the purified iodine fraction. Silver was separated by AgCl precipitation, and subsequent purification involved mainly the extraction of silver diethyldithiocarbamate into carbon tetrachloride. Tin was separated and purified by repeated extractions into 0.5M thenoyltrifluoroacetone in 4-methyl-2-pentanone followed by back-extractions into tartaric acid. Antimony was separated and purified by repeated extractions of antimonic chloride into isopropyl ether followed by back-extraction of the antimonous chloride into 7M hydrochloric acid. Cadmium was separated on an anion exchange column and purified by subsequent hydroxide and sulfide precipitations. Relative errors associated with the determination of each element were 15% or less except in the case of iodine. The trace elements determined in this study were found to fall into two general categories based on the distribution coefficients between the metal and troilite phases of iron meteorites: chalcophilic elements that concentrate strongly in the troilite with only minor siderophilic (metal-seeking) tendencies (Ag, Te, and I) and those that show appreciable siderophilic as well as chalcophilic properties (Sn, Sb, and In). Cadmium and indium, both volatile elements, were found to concentrate in the lunar soil samples relative to the lunar rocks, indicating an extralunar component in the soils. The extralunar component was estimated to be about 1.1% at the Apollo 12 site and about 2.2% at the Apollo 14 site assuming a carbonaceous chondrite-like nature for the extralunar component. Concentrations of most trace elements in the ultrabasic rocks are lower than in the basalts and other igneous rock types. Antimony is exceptional, with concentrations which are nearly the same in all rock types. The observed fractionation is compatible with the hypothesis that both basalts and ultrabasics are low-melting and high-melting fractions of upper mantle material, with the basalts being formed through a partial melting process with the ultrabasics constituting the residuum. (Diss. Abstr. Int., B)

52907 DETERMINATION OF BROMINE, ARSENIC, MERCURY, AND SELENIUM IN PLANTS BY NEUTRON ACTIVATION ANALYSIS. Chun, Sea Yull. Han'guk Sikp'um Kwahakhoe Chi; 3: No. 3, 144-50(1971).

As, Br, and Hg were determined in tobacco by Bethge destructive method and subsequent neutron activation analysis. Se-77m was determined by nondestructive activation analysis. Quantities of the element determined in Korean tobaccos are: As, 0.65 ppM; Hg, 0.74 ppM; Se, 1.18 ppM; and Br, 7.1 ppM. (Korean Sci. Abstr.)

52908 STUDY BY NEUTRON ACTIVATION ANALYSIS OF THE DISTRIBUTION OF Cs IN POTASSIUM MINERALS OF GRANITIC CORSICAN ROCKS. Carron, Jean-Paul; Lagache, Martine (Ecole Normale Superieure, Paris). Bull. Soc. Fr. Miner. Crist.; 95: No. 1, 161-2(Jan 1972). (In French).

Biotite and feldspath samples were irradiated in a neutron flux of $10^{13} n \cdot cm^{-2} s^{-1}$. The ^{134}Cs was determined by γ spectrometry. The quantity of Cs, and the K/Cs and Rb/Cs ratios found in the biotites and feldspars of granites and granodiorites are given in ppM. The distribution (by weight) of Cs between these two minerals is represented graphically. (France)

52909 DETERMINATION OF VANADIUM IN SILICATE MATERIALS BY NEUTRON ACTIVATION. Decarreau, Alain (Univ. Paris, Orsay, France); Jaffrezic, Henry. Compt. Rend., Ser. D; 274: No. 18, 2553-5(3 May 1972). (In French).

An original method for determination of vanadium by neutron activation is proposed; the application of this method to silicate rocks is described. The vanadium is isolated (before irradiation) from the principal undesirable elements by paper chromatography. Determinations are then made using γ spectrometry with a Ge(Li) detector. International interlaboratory comparisons were made using standard samples. (France)

52910 DETERMINATION OF BISMUTH IN SOME MINERALS BY ACTIVATION ANALYSIS. Babaev, A.; Khaidarov, A. Dokl. Akad. Nauk Tadzh. SSR; 13: No. 11, 21-2(1970). (In Russian).

The instrumental method described for determination of Bi in galena and chalcopyrite is based on the nuclear reaction $^{209}Bi(n,\gamma)$ ^{210}Bi; ^{210}Bi decays by β emission to form ^{210}Po, which in turn emits α particles to form ^{206}Pb. The sample and a standard of metallic Bi are wrapped in aluminum foil and irradiated in a thermal-neutron flux of $\simeq 1.8 \times 10^{13}$ neutrons/cm^2/sec. After 15 days for accumulation of ^{210}Po and decay of interfering isotopes, the irradiated sample is spread in a uniform layer over a standard transparent plastic cup to give infinite-thickness conditions, and the α activity is measured with use of a ZnS(Ag) scintillation counter. (Referativnyi Zh.)

52911 DETERMINATION BY NEUTRON ANALYSIS OF MERCURY RESIDUES IN FOODSTUFFS. Chun, Sea Yull Han'guk Sikp'um Kwahakhoe Chi; 3: No. 3, 135-43(1971).

Neutron activation analysis was used to determine the degree of mercury contamination in common foodstuffs. Polished rice con-

tained 0.050 ppM and rice bran had 0.095 ppM mercury. It was found in other grain in lesser amounts. Vegetables and fruits also contained 0.035 to 0.190 ppM of mercury with relatively small variations except for persimmons, which had a considerably higher amount of mercury. Soybean sprou' contained an unexpectedly high amount of mercury. Of the ' ..al products, chicken and eggs contained more mercury than mea. (Korean Sci. Abstr.)

52912 NEUTRON ACTIVATION ANALYSIS. De Soete, D.; Gijbels, R.; Hoste, J. Chemical Analysis, Volume 34. New York; John Wiley and Sons, Inc. (1972). 856p. $39.50.

Titles of the twelve chapters are: activation analysis, general aspects in trace analysis, neutron-induced reactions, neutron sources, growth and decay of radioactivity during and after irradiation, nuclear disintegration and radiation detection, preparation of samples and standards, activation analysis with post-irradiation radiochemical separations, analysis without chemical separation, systematic errors in activation analysis, statistical interpretation of results, and, bibliographical survey of neutron activation analysis. Also included are appendixes on thermal neutron cross sections, resonance neutron cross sections, fission neutron cross sections, 14-MeV neutron cross sections, gamma energies of radionuclides formed by neutron capture and determined by Ge(Li) spectrometry, gamma mass attenuation coefficients, and chemical yield determinations. (J.G.B.)

Chemical and Spectral Procedures

Refer also to abstracts 52955 and 55170.

52913 (AEC-tr-7345) ABSOLUTE MEASUREMENT OF THE ISOTOPIC RATIO OF A WATER SAMPLE WITH A VERY LOW DEUTERIUM CONTENT. Hagemann, R.; Nief, G.; Roth, E. Translated for Savannah River Lab., Aiken, S. C., from report CEA-R-3633. 25p. Dep. NTIS.

A method was developed for the isotopic determination of hydrogen in water very depleted in deuterium. It is based on utilization of a distillation column mounted directly on the introduction line of a mass spectrometer. The latter is equipped with an isotope ratio measuring apparatus the sensitivity of which is better than 0.01 ppM. The column used permits a high separation factor, above 5000, to be obtained, so that it is possible to measure the response of the mass spectrometer for a vapor containing less than 0.001 ppM of deuterium. This method was applied for determining the isotopic ratios of three depleted waters. The results obtained allowed the assignment to the most depleted among the others an absolute value in deuterium equal to 1.71 ± 0.03 ppM. This water constitutes the primary standard used to determine the isotopic ratio of a natural water serving as a laboratory standard. (auth)

52914 (ANL-7860(Pt.3), pp 55-63) DETERMINATION OF SELECTED TRACE ELEMENTS IN NATURAL WATER SAMPLES USING SPARK SOURCE MASS SPECTROSCOPY. Wahlgren, M. A.; Edgington, D. N.; Rawlings, F. F. [nd].

In Radiological Physics Division annual report, January–December 1971.

A spark source mass spectroscopic method for analyzing water samples from the South Basin and from tributaries to the South Basin and Green Bay regions of Lake Michigan for twenty-one selected trace elements of radiological, biological, and geochemical interest is described. The elements determined include B, F, Al, Si, P, V, Cr, Mn, Ni, Cu, Zn, Se, Ag, Cd, Sn, Sb, I, Ba, Pb, Bi, and U. (D.H.M.)

52915 (CONF-720827-2) RAPID, SENSITIVE METHOD FOR THE DETERMINATION OF THE CHEMICAL OXYGEN DEMAND OF POLLUTED WATERS. Pitt, W. Wilson Jr.; Katz, Sidney; Thacker, Louis H. (Oak Ridge National Lab., Tenn.). 1972. 20p. Dep. NTIS.

From seventy-third national meeting of the American Institute of Chemical Engineers; Minneapolis, MI. (27 Aug 1972).

A rapid, sensitive cerate oxidative method for measuring the chemical oxygen demand (COD) of waters is described. The pollutants are oxidized with perchlorato-cerate reagent and the resulting cerium(III) is determined fluorometrically. Analysis requires only a few minutes for determinations at levels as low as 100 μg oxygen demand per liter. Results of tests on solutions of known organic compounds, various industrial waste streams, and natural waters show that the method compares favorably with the dichromate reflux procedure. However, the new method is considerably faster and easier to use, and is a hundred times more sensitive. An analytical system suitable for use as either a continuous COD monitor or as an analyzer for multiple samples in series is also described. (auth)

52916 (EUR-4765, pp 41-75) HIGH ACCURACY ISOTOPE ANALYSIS OF THE ELEMENTS. De Bievre, P. (Central Bureau for Nuclear Measurements, Geel, Belg.).

From 2nd conference on mass spectrometry; Ispra, Italy (1 Sep 1971).

The need and means for acquiring reliable data in the field of isotope analysis are discussed. Suggested requirements for accurate analyses are: enriched isotopes (>99% isotopic purity) of the element concerned, accurate chemical assay of these isotopes (accuracy 0.1%), accurate blending of these isotopes, calibration of the mass spectrometer with these blends, and isotopic measurement of natural samples of the element concerned. Best available estimates of natural isotope abundances for the elements are tabulated. (J.G.B.)

52917 (EUR-4765, pp 77-89) APPLICATION AND AUTOMATION OF MASS SPECTROMETRY IN THE ANALYSIS OF IRRADIATED NUCLEAR FUELS. Cricchio, A.; Gerin, F.; Koch, L.; Wilhelmi, M. (European Transuranium Inst., Karlsruhe, Ger. Gesellschaft fuer Kernforschung, Karlsruhe, Ger.). (In Italian).

From 2nd conference on mass spectrometry; Ispra, Italy (1 Sep 1971).

A procedure is given for the analysis of irradiated nuclear fuels, beginning with their dissolution in HNO_3, and the spectrometric analysis of the fission gases liberated during dissolution. Six Kr and six Xe isotopes were thus determined. Another mass spectrometer was used to assay four U isotopes and six Pu isotopes. The isotope ^{238}Pu and the isotopes of Am and Cm were determined by alpha spectrometry. The extent of burn-up was obtained from a determination of ^{148}Nd by means of an isotopic dilution technique, using ^{150}Nd as an indicator. Automation of some of the procedures and data processing by computer are described. (K.S.W.)

52918 (EUR-4765, pp 91-115) ISOTOPIC ANALYSIS OF URANIUM AS A RUNNING CONTROL OF THE EUREX PROCESS. Pozzi, F.; Trincherini, R. P. (CNEN, Vercelli, Italy). (In Italian).

From 2nd conference on mass spectrometry; Ispra, Italy (1 Sep 1971).

Preliminary tests are described that served to prepare a Varian CH_4–B spectrometer for the widest possible interval for uranium isotopes. National Bureau of Standards samples were utilized in these adjustments. The complete procedure for the determination of U and of the relative percent of the U isotopes present is given. Dissolution of the EUREX Plant product yields a solution of U enriched to 80 to 90% and a concentration between 2 and 3 g U/l. Glove-box preparation of the sample, extraction of U with methyl isobutyl ketone after complexing with tetrapropylammonium nitrate, and the pertinent calculations and statistical treatment of the data are described. Variations in the relative isotopic abundance and their relation to current control of the EUREX process are discussed. (K.S.W.)

52919 (NIM-1432) DETERMINATION OF RUTHENIUM AND OSMIUM IN THE RESIDUES RESULTING FROM THE LEACHING OF MATTES. Krueger, Magdalena M.; Robert, R. V. D. (National Inst. for Metallurgy, Johannesburg (South Africa)). 5 Jul 1972. 4p. Dep. NTIS (U. S. Sales Only).

The residue is sintered with barium peroxide, and the ruthenium and osmium distilled from the sinter. The distillates are collected separately in 6N hydrochloric acid. The ruthenium is determined by atomic absorption spectrophotometry and the osmium by a colorimetric method using thiourea. (auth)

52920 (RT/CHI-(72)3) PROGRESS IN STANDARDIZATION OF ANALYTICAL METHODS FOR MATERIALS OF NUCLEAR INTEREST. I. STANDARD METHOD FOR SPECTROPHOTOMETRIC DETERMINATION OF HEXAVALENT URANIUM IN AQUEOUS AND NON-AQUEOUS SYSTEMS BY DIBENZOYLMETHANE. Castagnola, A. M.; Guidotti, G. R.; Lorenzini, L.; Pigozzi, G. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 4 Mar 1972. 39p. Dep. NTIS (U. S. Sales Only).

The spectrophotometric method for determination of uranium (VI) by using dibenzoylmethane (1,3-diphenyl-1,3-propanedione) as a chromogenic reagent was revised and standardized for analytical control purposes. The method can be applied to the analysis of aqueous systems containing nitric and oxalic acid as well as thorium(IV) and stainless steel corrosion products and of TBP and tricaprylamine nonaqueous systems containing nitric acid. The applicability range in aqueous and nonaqueous systems is 0.04 to 50 and 0.01 to 2.5 g/l of uranium(VI), respectively. Limits for the mean at a level of about 0.13 mg U(VI)/25 ml and a probability of 0.05 (5% risk) in aqueous and nonaqueous systems of ±0.5 (for 15° of freedom) and ±1% (for 9° of freedom), respectively, were obtained. A statistical control was also made on the accuracy of determinations of an aqueous standard solution containing 500.0 mg/l of uranium(VI). Thirty-two measurements were made during a period of two months and upper and lower control limits of 511.8 and 488.2 mg/l were obtained respectively, without evidence of lack of control. (auth)

52921 ATOMIC ABSORPTION DETERMINATION OF ALKALINE EARTH METALS AND REFRACTORY OXIDES IN GEOCHEMICAL STANDARDS WITH A NITROUS OXIDE–ACETYLENE FLAME. Luecke, Werner (Univ., Karlsruhe, Ger.). Neues Jahrb. Mineral., Monatsh.; No. 6, 263-88(1971). (In German).

Beryllium, Mg, Ca, Sr, Ba, Ti, V, Cr, Mn, and Fe were determined by atomic absorption spectroscopy using a nitrous oxide–acetylene flame. Interference due to thermal ionization was suppressed by addition of large amounts of an easily ionized alkali metal, e.g., Cs. Silicates were decomposed for the determination of major and minor elements with $Li_2B_4O_7$ melts in platinum–gold crucibles. To determine trace elements the samples were treated with HF–$HClO_4$ under pressure in a PTFE-lined bomb followed by volatilization of Si. (Anal. Abstr.)

52922 DETERMINATION OF URANIUM IN HIGH-ALLOY STEEL. Peisteiner, E. (Schoeller-Bleckmann Stahlwerke AG, Ternitz, Austria). Radex. Rundsch.; No. 2, 442-6(1971). (In German).

A wet-chemical method was developed in order to calibrate the x-ray fluorescence determination of uranium. The steel sample is dissolved in HCl containing a few drops of HF, and the solution is oxidized with HNO_3. The uranium is extracted with tributyl phosphate–isobutyl methyl ketone. The uranium is reextracted from the organic phase by an aqueous solution of ammonium acetate and ammonium fluoride, and the pH is adjusted to 7.6. The resulting aqueous phase is extracted with 8-hydroxyquinoline solution in $CHCl_3$ and the extinction of the $CHCl_3$ layer is measured at 470 nm. Results obtained on samples containing up to 0.2% of uranium were rectilinearly related to counting rates obtained with a vacuum x-ray fluorescence spectrometer. (Anal. Abstr.)

52923 CALORIMETRIC METHODS OF ANALYSIS. Pennington, Sam N. (East Carolina Univ., Greenville, N. C.). Rev. Anal. Chem.; 1: No. 2, 113-40(1972).

The area of calorimetry considered is solution calorimetry, i.e. the heat absorbed or evolved when two solutions are mixed. The theory of thermal analysis is reviewed. Instruments, measurements, analytical determinations, kinetic measurements, and other applications are discussed. Radiochemical calibration for measurements is considered. (39 references) (M.C.G.)

52924 AMPEROMETRIC AND POTENTIOMETRIC DETERMINATION OF COPPER AND MOLYBDENUM IN ORE CONCENTRATES AND ALLOYS WITH 5-BROMO-8-MERCAPTO- AND 8-MERCAPTO-4-METHYLQUINOLINE. Berzina, V.; Jansons, E.; Priedite, R. Uch. Zap., Latv. Gos. Univ.; 117: 138-41(1970). (In Russian).

Either of these reagents (I and II, respectively) can be used as a titrant for Cu or Mo. The amperometric titration of Cu with I solution is carried out in a basal electrolyte of N H_2SO_4 and that with II solution in a basal electrolyte of HCl–KCl buffer solution (pH 2) at +0.9 V; in the presence of Pb the titration is carried out with 0.5 N H_2SO_4 as basal electrolyte. For the determination of Mo, the sample is mixed with concentrated H_3PO_4 (if W is present) and adjusted with 20% NaOH solution to pH 2, then diluted with one of the basal electrolytes specified above and titrated. Potentiometric titration is carried out similarly with use of a platinum electrode and the S.C.E. The method is suitable for the determination of Cu in bronze, brass, nickel silver, duralumin, silumin, and coinage alloy, and for the determination of Mo in steel; procedures are given. (Referativnyi Zh.)

52925 RAPID SPECTROPHOTOMETRIC DETERMINATION OF TANTALUM IN HARD-METAL ALLOY MIXTURES USING NILE BLUE. Panteleeva, M.; Dimitrova, M. (Forschungsinstitut fuer Metallkeramik, Sofia). Z. Anal. Chem.; 260: No. 4, 290-1 1972). (In German).

A sensitive method for determination of tantalum in hard metal alloys is described. The method is based on complexing the tantalum and extracting the colored compound with organic solvents. Within three hours, five samples can be analyzed. (H.B.G.)

52926 SPECTROPHOTOMETRIC STUDY OF THE REACTION OF NIOBIUM WITH ALIZARIN RED S [C.I. MORDANT RED 3]. Akhmedli, M. K.; Chan Khiem Tkham; Gambarov, D. G. Uch. Zap. Azerb. Gos. Univ., Ser. Khim. Nauk; No. 3, 46-50(1970). (In Russian).

Complex formation between Nb(V) and Alizarin red S (I) was studied as a function of pH, concentration of I, concentration of the complex-forming substance added to prevent hydrolysis of the Nb, and presence of salts of Na^+, K^+, and NH_4^+ (which enhance the sensitivity and selectivity of the reaction). The sensitivity of the reaction diminishes in the series of systems Nb–EDTA, Nb–oxalate, Nb–tartrate and Nb–KOH. Complex formation generally attains maximum at pH 5 except for the Nb–EDTA system, for which the optimum pH is 4 (or 3 in the presence of salts). The maximum absorption of the complex is at 500 nm in the absence of salts and at 540 nm in their presence; the corresponding molecular extinction coefficients are 18,000 and 87,000. Color development takes 15 min in the absence of salts, but 4, 45, or 15 h in the presence of K^+, NH_4^+, or Na^+, respectively. (Referativnyi Zh.)

52927 SPECTROGRAPHIC DETERMINATION OF NICKEL, COBALT, SILVER, VANADIUM, TIN, MOLYBDENUM, TITANIUM, ALUMINUM, BISMUTH, IRON, LEAD, AND MANGANESE IN NATURAL WATER IN THE PRESENCE OF RELATIVELY LARGE AMOUNTS OF COPPER. Eremenko, V. Ya.; Mel'nikov, E. A. Gidrokhim. Mater.; 54: 87-90(1970). (In Russian).

The effect of Cu on the determination of heavy metals in water was studied. For Cu contents up to 120 μg per liter, all the elements named (except Ag) can be determined with an error of <20%. For >160 μg of Cu per liter, the Cu must first be separated (by extraction, as its dithizone complex, from a weak acid solution containing NH_4SCN); some Ag and Sn are extracted with the Cu. After removal of most of the Cu, the pH is adjusted to ≈5, and the other elements are extracted as their complexes with diethyldithiocarbamate and 8-hydroxquinoline. The extracts are analyzed by accepted spectrographic methods. (Referativnyi Zh.)

52928 DIRECT SPECTROPHOTOMETRIC DETERMINATION OF BORON IN ALUMINIUM ALLOYS. Pakalns, P. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Metallurgia; 39: No. 8, 308-9(Aug 1972).

A procedure is presented for the spectrophotometric determination of boron in aluminium and aluminium alloys. The sample is dissolved in a mixture of sulphuric, nitric, and hydrochloric acids, and the nitrate reduced with formic acid. An aliquot of the solution is treated with acetic anhydride, curcumin added, followed by an acetone-water mixture, and the absorbance of the boron-curcumin complex measured. (auth)

52929 TECHNIQUE FOR THE QUALITATIVE SPECTROGRAPHIC ANALYSIS OF VERY SMALL SAMPLES. Christopher, A. J. (Royal Aircraft Establishment, Farnborough, Eng.). Microchem. J.; 17: No. 4, 470-5(Aug 1972).

The sample and a small yarn of carbon fibers are stuck on a pointed graphite electrode; the gap between this and the upper electrode is bridged by the carbon fibers, which strike the arc when the dc source is switched on. Background emission is greatly reduced by enclosing the arc in an argon atmosphere. Many elements can be detected with ease in 1 μg amounts. Molybdenum was one element determined by this method. (auth)

52930 MICRODETERMINATION OF METALS IN ORGANOMETALLIC COMPOUNDS BY THE OXINE METHOD AFTER OXYGEN FLASK COMBUSTION. I. CADMIUM, MAGNESIUM, URANIUM, AND ZINC. Sakla, A. B.; Bishara, S. W.; Abo-Taleb, S. A. (Cairo Univ., Giza, Egypt). Microchem. J.; 17: No. 4, 436-42(Aug 1972).

A simple, accurate, and relatively rapid procedure for the estimation of cadmium, magnesium, uranium, and zinc in organometallic compounds is presented. The oxygen-filled flask is recommended for decomposition of the organic sample. Determination of the metal concerned is carried out by three methods using a single sample weight. Both the gravimetric and titrimetric finishes are applied. The method has the advantage of a favorable conversion factor for the gravimetric determination besides an 8- or 12-fold amplification reaction, depending on the valence of the metal, in case of the titrimetric finish. (auth)

52931 SPECTROPHOTOMETRIC DETERMINATION OF MOLYBDENUM AND PHOSPHORUS BY CARMINIC ACID METHOD. Lee, Albert; Boltz, D. F. (Wayne State Univ., Detroit). Microchem. J.; 17: No. 4, 380-7(Aug 1972).

A spectrophotometric method for the determination of molybdenum based on the use of carminic acid is proposed. Conformity to Beer's law was observed with an optimum concentration range of 1.5 to 8 ppM of molybdenum when absorbance measurements were made at 565 nm. The molar absorptivities for the determination of molybdenum are 1.4×10^4 mol l^{-1} cm^{-1} at 565 nm and 5.1×10^3 mol l^{-1} cm^{-1} at 336 nm. An indirect spectrophotometric procedure for the determination of orthophosphate based on the determination of the equivalent molybdenum in 12-molybdophosphoric acid was developed suitable for the determination of 0.03 to 0.18 ppM of phosphorus. (auth)

52932 QUANTITATIVE SPECTRAL DETERMINATION OF Nb, Ta, Fe, AND Mn IN MINERALS OF THE COLUMBITE–TANTALITE GROUP. Galibin, V. A.; Tsyina, N. V. Mineral. Geokhim.; No. 4, 77-84(1972). (In Russian).

A method of quantitative spectral determination of the composition of columbite–tantalite type minerals was developed employing a direct measurement of the ratios Nb_2O_5/Ta_2O_5 and FeO/MnO and 10 mg of sample. Preparation of the Nb, Ta, Fe, and Mn standards is described in detail. The mean arithmetic error in the oxide contents, based on the ratios determined,

was 5.7% for Nb_2O_5, 6.5% for Ta_2O_5, 5.6% for FeO, and 7.0% for MnO. (K.S.W.)

Radiometric and Radiochemical Procedures

Refer also to abstracts 53256 and 54084.

52933 (JAERI-Memo-4094) APPLICATION OF ELECTROPHORESIS FOR BURNUP DETERMINATION. Hayashi, Teiji; Ito, Tadaharu; Nakayama, Shiro (Japan Atomic Energy Research Inst., Tokyo). Aug 1970. (In Japanese and English). NTIS (U. S. Sales Only).

Nuclear fuel burnup determination by electrophoresis with remote handling is described. The separation of inorganic components by electrochromatography was applied to the burnup determination. Some experiments were carried out on the separation of ^{137}Cs, one of the indicators for burnup determination, in the highly radioactive solution of an irradiated fuel specimen. The results by this method were found to be in agreement with those by a conventional radiochemical analysis. (auth)

52934 (MLM-1368) NEW TECHNIQUES FOR RELATIVE CALIBRATION OF TRITIUM SOURCES BY BREMSSTRAHLUNG COUNTING. Curtis, M. L.; Bentz, L. L. (Mound Lab., Miamisburg, Ohio). 15 May 1966. Contract AT-33-1-Gen-53. 12p. Dep. NTIS.

Where the very soft beta radiation from tritium cannot be detected and measured readily because of its chemical or physical form, the more penetrating bremsstrahlung radiation can be measured as a convenient method of analysis. Techniques are described for rapid measurement of a large number of liquid or solid samples sealed in circular polyethylene bags, using a thin window sodium iodide crystal and multichannel analyzer. Disintegration rates are determined by comparison with the bremsstrahlung counting rate of standardized tritiated water. Empirical corrections are made for the differences in bremsstrahlung intensity due to sample composition. The method was used in studies of hydrogen penetration into steel, the measurement of tritium absorbed in charcoal, the determination of tritium in contaminated and discolored pump oil, and in aqueous waste materials. It is applicable to analysis for tritium in any material that can be contained in polyethylene, in the range of one microcurie per cc or higher. (auth)

52935 (MLM-1888) MOUND LABORATORY CHEMISTRY AND PHYSICS PROGRESS REPORT: OCTOBER-DECEMBER 1971. (Mound Lab., Miamisburg, Ohio). 21 Aug 1972. Contract AT-33-1-Gen-53. 24p. Dep. NTIS.

LITHIUM SULFATES—analysis for impurities, spectrographic
NATURAL WATERS—plutonium in, possibility of pentavalent
PLUTONIUM—chemical state in solutions, effects of hydrolysis on
—content of pentavalent, in natural waters, possibility of
—determination in soil, sample size for fusion method for
—separation from uranium, residue adsorption and anion exchange methods for
PLUTONIUM-238—analysis for uranium-232 and uranium-234 by hydrolysis, residue adsorption, and α spectroscopy
SOILS—analysis for plutonium, sample size for fusion method for
TRITIUM—determination by liquid scintillation counting
URANIUM—separation from plutonium, residue adsorption and anion exchange methods for
URANIUM-232—determination in plutonium-238 and uranium-234 by hydrolysis, residue adsorption, and α spectroscopy
URANIUM-234—determination in plutonium-238 and uranium-232 by hydrolysis, residue adsorption, and α spectroscopy
—purification of, anion exchange method for (M.C.G.)

52936 (RT/EL-(72)4) ELECTRON EMISSION FROM SOLIDS BY IONIC BOMBARDMENT. Catoni, F.; Gislon, R.; Papa, C. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 13 Apr 1972. 31p. (In Italian). Dep. NTIS (U. S. Sales Only).

Ejection of electrons by low-energy ion bombardment is the basis of methods of surface analysis. The physical fundamentals involved are reviewed. (45 references) (auth)

52937 ANALYSIS USING SECONDARY ION EMISSION IN SEMICONDUCTORS. Blanchard, B.; Hilleret, N.; Quoirin, J. B. (CEN, Grenoble, France). pp 393-400 of International Colloquium on the Application of Vacuum Techniques to the Semiconductor Industry, Electronic, and Microelectronic Components. Paris; Societe Francaise des Ingenieurs et Techniciens du Vide (1971). (In French).

From third international symposium on the application of vacuum techniques in semiconductor industry, electronic components, and microelectronics; Versailles, France (13 Sep 1971). See CONF-710932.

The Castaing-Slodzian ion analyzer was used to determine impurity profiles in semiconductors (impurity distributions determine most of the electrical properties). The measurement methods are described in detail using the diffusion profiles of B in Si and silica as examples. This method enables curves to be rapidly obtained for the distributions. (France)

52938 RADIOCHEMICAL DETERMINATION OF VITAMIN B_{12}. Iversen, M. S. (Dr. Fuersts Medisinske Laboratorium, Oslo). Fysiokjemikeren; No. 9, 6-9(Mar 1971). (In Norwegian).

A new method for the determination of vitamin B_{12}, based on isotopic dilution and ultrafiltering, was developed. A competitive absorption between labeled and nonlabeled B_{12} to "intrinsic factor" is utilized. Vitamin B_{12} in the blood is released from serum protein by warming at pH 4.9 in the presence of cyanide. Cobalt-57-labeled B_{12} and "intrinsic factor" are added. The solution is ultrafiltered and the amount of vitamin B_{12} in the sample can be calculated from the radioactivity in the filtrate. The quality of the labeled solution and the "intrinsic factor" are important factors. Details of the procedure are given. The results give good agreement with the microbiological method and have the advantage of being available the same day the samples are taken. Batches of 40 samples, including standards and controls, prove suitable. (Norway)

52939 MICROANALYSIS OF MATERIALS BY BACKSCATTERING SPECTROMETRY. Nicolet, M.-A. (California Inst. of Tech., Pasadena); Mayer, J. W.; Mitchell, I. V. Science; 177: No. 4052, 841-9(8 Sep 1972).

A survey is presented of backscattering spectrometric analysis and its applications. This technique is sensitive to the mass of the constituents, their depth distribution, and the crystalline structure. Some of the applications include ion-implanted semiconductors, dielectric layers, metal-semiconductor contacts, metal analyses, films (such as in paper industry), etc. Sensitivity and limitations of the technique are discussed. (11 figures, 33 references) (D.L.C.)

52940 DETERMINATION OF URINARY PLUTONIUM BY RADIOCHEMICAL ANALYSIS ON ION EXCHANGER FILTERS. Clanet, F. (Laboratoire de Chimie Minerale et d'Hydrologie, Tours, France); Ballada, J.; Lucas, J.; Gil, C. Health Phys.; 23: No. 2, 244-7(Aug 1972). (In French).

Background studies and a recommended method are described for determining Pu in urine, which involves separation of Pu(IV) on an HAWP Millipore filter supporting three Amberlite SB-2 ion exchange filter papers. The detection limit claimed is 1 pCi ^{239}Pu/liter of urine. There is excellent agreement between the results of this method and the standard one involving separation of Pu on an ion exchange column, but the described method is far quicker. (UK)

52941 RADIOMETRIC METHOD FOR STANDARD URANIUM ORE SAMPLES: COMPARISON WITH STANDARD THORIUM ORE SAMPLES BY MEANS OF THE GAMMA RAYS SPECTROSCOPY. Krzuk, Jerzy (Instytut Techniki Jadrowej, Krakow). Nukleonika; 16: No. 11-12, 555-64(1971). (In Polish).

A possibility of the thorium content comparison with that of uranium in the standard samples by means of gamma spectroscopy is shown. The basis of the described method is that both ThC'' (^{208}Tl) in thorium series, and RaC (^{214}Bi) in uranium series emit gamma rays of energy ~0.6 MeV. (auth)

52942 METODE RADIOMETRICE DE ANALIZA. (Radiometric Methods of Analysis). Nascutiu, Tiberiu. Bucharest; Editura Academiei Republicii Socialiste Romania (1971). 346p. (NP-19380).

Physical fundamentals of the use of the radioactive isotopes in analytical chemistry are reviewed. Radiometric methods of analysis are described. The basic principle of each method, the necessary apparatus, the errors affecting the determinations, and achievements and outlooks at laboratory and plant level are discussed. Former methods, based on direct measurements of radioactivity, excellent methods for the determination of uranium, thorium, radium, potassium, and of other elements having natural radioactive isotopes, are also described. Methods based on the use of artificial radioactive sources are given. In the case of x-ray fluorescence analysis using such sources, advantages of the substitution of the x-ray generator tube (classical method) and possibilities of construction of a simplified, portable and cheaper apparatus for rapid, routine analysis in hard field conditions, are also exposed. Gas analysis by ionization with radioactive sources and methods based on the attenuation of nuclear radiations (absorption and back scattering), the Mössbauer effect, and the scattering of charged particles are described. Special attention was paid to neutron methods, at present widely developed as a result of nuclear reactors, charged particles accelerators, and neutrons

isotopic sources improvement and marketing. Specific features of the methods of analysis by activation with thermal neutrons, with fast neutrons, with charged particles, and with photons are given. (auth)

52943 INVESTIGATIONS OF THE EQUIVALENCE BETWEEN HEAVY ELEMENTS CONCENTRATIONS IN THE ROCK: USE OF THE GAMMA–GAMMA SELECTIVE METHOD. Charbucinski, J.; Gyurcsak, J. (Instytut Techniki Jadrowej, Krakow). Nukleonika; 17: No. 1-2, 123-9(1972). (In Polish).

The relationship of the equivalence factor to Z_{eq} of matrix value, and initial energy of the source applied to the measurement as well as to the atomic number of the element that is the additive component of the rock, is also described. The equivalence factors for Fe, Mo, Ba, and Pb in the range of energy 60 keV to 661 keV were investigated. The semiempirical determination of equivalence factors is introduced. (auth)

52944 USE OF THE KNOBLOCH ELEMENTARY MICRO-ANALYZER FOR THE COMBUSTION OF ANALYTICAL SAMPLES CONTAINING ^{14}C AS A PRESTAGE OF LIQUID SCINTILLATION MEASUREMENT. Mende, G. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Isotopenpraxis; 8: No. 2, 71-2(Feb 1972). (In German).

The modifications made in the procedure used with the Knobloch elementary microanalyzer so that it could be used for the combustion of analytical samples as a pre-stage of liquid scintillation measurement were described. The modifications were tested on a ^{14}C-labeled benzoic acid sample. From 41 combustions a relative standard deviation of the individual values of 0.7% was obtained. (J.S.R.)

52945 FULL-RANGE SOLUTION FOR THE MEASUREMENT OF THIN-FILM SURFACE DENSITIES WITH PROTON-EXCITED X RAYS. Reuter III, F. William; Smith, Harold P. Jr. (Univ. of California, Berkeley). J. Appl. Phys.; 43: No. 10, 4228-32 (Oct 1972).

A Fredholm-integral expression for characteristic x-ray production by proton bombardment is developed relating multicomponent elemental thin-film concentration profiles to proton-stopping power, x-ray-production cross section, and x-ray attenuation. The thickness of Al_2O_3 and Ta_2O_5 films on their respective metallic substrates were measured with 20- to 80-keV protons with an accuracy of 5% for thick films (1200 Å) and 25% for thinner films (30 Å). Nonlinear regression analysis of the data indicated that all parameters of interest, including the zero-voltage anodization potential, can be determined from the raw data. With exception to the oxygen K-shell x-ray attenuation coefficient, the parameters were determined with good to reasonable accuracy. A general concentration profile could not be determined by numerical methods as a result of insufficient variation in the kernel of the integral equation. (auth)

52946 CORRECTION OF A FORMULA USED IN THE RADIOASSAY OF ^{99m}Tc. Banerjee, Krishnadas; McAllister, John D.; DiPrimio, Joseph; Henry, Maureen L. (St. Francis General Hospital, Pittsburgh). Radiology; 104: No. 3, 711-12(Sep 1972).

A formula was derived for the radioassay of ^{99m}Tc using a ^{57}Co standard source, employing the number of usable photons produced by the decay of the respective isotopes. The activity of ^{99m}Tc, as determined with NaI (Tl) well-crystal and Ge(Li) detectors, compares favorably with that measured with two different commercially available dose calibrators. (auth)

Separation Procedures

Refer also to abstract 52954.

52947 (BM-RI-7671) SEPARATION OF COLUMBIUM, TANTALUM, TITANIUM, AND ZIRCONIUM FROM TITANIUM CHLORINATION RESIDUES. Merrill, Carl C.; Couch, D. E. (Bureau of Mines, Boulder City, Nev. Boulder City Metallurgy Research Lab.). 1972. 10p.

Niobium, tantalum, titanium, and zirconium are present in solid-waste products generated by the chlorination of rutile used for production of titanium tetrachloride ($TiCl_4$). The niobium and tantalum were separated from titanium and zirconium by liquid-liquid extraction techniques using a secondary amine. Salts of these elements are in a leach liquor produced by water leaching of mineral waste from the chlorination of rutile. This waste, produced at the rate of approximately 50,000 tons per year, is about 40 wt % water soluble. Leach liquors, separated by filtration, were further separated into a solid fraction and a liquid fraction by pressure hydrolysis. The solid fraction containing Nb, Ta, Ti, and Zr was dissolved in HCl-HF and used as a feed solution. Niobium and tantalum were removed from the organic extractant with 1 N HCl. A miniature 10-stage reactor showed that the niobium and tantalum present in solution could be separated with a continuous flow. (auth)

52948 USE OF ION EXCHANGERS IN ANALYTICAL CHEMISTRY. Inczedy, J. (Univ. of Chemical Industries, Veszprem, Hungary). Rev. Anal. Chem.; 1: No. 2, 157-74(1972).

Recent applications of ion exchange are reviewed and trends in the development of ion-exchange chromatography are shown. Topics covered include: ion exchange materials, methods based on total ion exchange, chromatographic separation, separation of metal ions by cation exchangers, separation of organic bases on cation exchange columns, separation of metal ions by anion exchange columns, separations of anions and of organic acids with anion exchangers, new techniques, liquid ion exchangers, and ion exchange papers. (135 references) (M.C.G.)

52949 CHROMATOGRAPHIC SEPARATION OF INDIUM FROM ELEMENTS THAT FORM PERIODATES OF LOW SOLUBILITY, AND ITS SUBSEQUENT DETERMINATION. Verdizade, A. A.; Mekhtiev, M. M. Uch. Zap. Azerb. Gos. Univ., Ser. Khim. Nauk; No. 3, 42-5(1970). (In Russian).

The separation of In from such elements as (Cu, Zn, Al, Bi, Pb, Mo, Cd, Fe, Cr, Sn, As, Sb, Co, Ni, and Ga) is achieved by the ion-exchange chromatography of complexes with sulfosalicylic acid on a column of KU-2 cationite (NH_4^+ form). To the aqueous test solution is added aqueous NH_3 until the color changes to orange–yellow, then the solution is diluted and passed through the column, which is washed (×3 or 4) with 4% aqueous sulfosalicylic acid (neutralized with aqueous NH_3) and then with water (×3 or 4). At this stage, there remain on the column only the complexes of In, Ga, Co, Ni and C(III). The column is then washed with 0.4 to 0.5M HCl, which elutes In, Cr, Co, and Ni; the eluate is evaporated, concentrated aqueous NH_3 is added to precipitate In and Cr, the precipitate is collected, washed with aqueous NH_3 and dissolved in 2M HNO_3, then saturated aqueous $NaIO_4$ is added, and the mixture is neutralized to 4-nitrophenol with 10% aqueous NaOH. Dilute HNO_3 is added until the pH is between 2 and 7, and the solution is heated to 80° and filtered; the precipitate is washed with hot 1% ammonium acetate solution then dissolved in M H_2SO_4, benzene and M KI are added, and the liberated iodine is titrated with $Na_2S_2O_3$ solution. The method is applicable to the determination of In in phosphate concentrates. (Referativnyi Zh.)

52950 RECOVERY OF RHENIUM AND MOLYBDENUM VALUES FROM SOLUTION. Litz, John E. (to Continental Ore Corp.). U. S. Patent 3,681,016. 1 Aug 1972. Filed 2 Dec 1970.

A process is described for recovering rhenium and molybdenum values from solution. The soluble molybdenum and rhenium values are extracted with an amine solvent, the values stripped from the amine extract with an ammonium hydroxide solution, the strip solution of copper, iron, silicon, phosphorous, and arsenic purified, the molybdenum crystallized as ammonium tetramolybdate containing a minimum of rhenium and other impurities, and the rhenium concentrated and recovered from the crystallization mother liquor by amine solvent extraction, stripping with sodium hydroxide solution, extraction into a pyridine solvent, and distillation of the pyridine away from a rhenium salt. (Official Gazette)

52951 ION-EXCHANGE BEHAVIOUR OF METALS ON DEAE-CELLULOSE IN METHANOL–THIOCYANATE–HYDROCHLORIC ACID MEDIA. Kuroda, Rokuro; Kondo, Takaaki; Oguma, Koichi (Univ. of Chiba, Japan). Talanta; 19: No. 9, 1043-8(Sep 1972).

Only a few metals can be adsorbed on DEAE-cellulose (diethylaminoethylcellulose) from aqueous thiocyanate-chloride media. However, several metal ions, including Cu(II), Zn, Cd, In, Bi and U(VI), exhibit enhanced adsorption on DEAE-cellulose from methanol-thiocyanate-hydrochloric acid mixtures. The distribution coefficients for these metals are given as functions of methanol, ammonium thiocyanate, and hydrochloric acid concentration. Differences in adsorption among metals permit many useful separations, including Ni, Cu, and Zn; mixed rare earths and hexavalent U; Cd and In; Ga and In; and Al and In, on short columns containing 1 to 1.5 g of DEAE-cellulose. (auth)

52952 SYNERGISTIC EFFECT OF TRI-n-OCTYLAMINE ON THE SOLVENT EXTRACTION OF CERIUM(III) BY THENOYLTRIFLUOROACETONE. Newman, L.; Klotz, P. (Brookhaven National Lab., Upton, N. Y.). Inorg. Chem.; 11: No. 9, 2150-4(Sep 1972).

The synergistic effect of tri-n-octylamine (R_3N) on the solvent extraction of cerium by thenoyltrifluoroacetone (HT) is shown to arise from the organic-phase reactions $CeT_3 + R_3NHCl = CeT_3R_3NHCl$, $CeT_3 + R_3NHT = CeT_3R_3NHT$, and $CeT_3 + R_3NHClHT = CeT_3R_3NHClHT$, where T^- represents the enolate ion of HT. It was ascertained that the formation constants for each of these reactions as measured in benzene are the same, and a value was found for $\log K_S = 4.83 \pm 0.15$. The synergistic effect in this system was found to be identical in kind and almost in magnitude with that observed in a previous investigation involving americium. (auth)

Inorganic, Organic, and Physical Chemistry

Refer also to abstract 53027.

Chemical and Physico-chemical Properties

Refer also to abstracts 52895, 53033, 53055, and 53664.

52953 (CONF-720716-1) SURFACE INTERACTIONS OF IODINE WITH Fe_3O_4. Hoinkis, E. (Oak Ridge National Lab., Tenn.). [nd]. 31p. Dep. NTIS.

From International conference and exhibition on vacuum instruments and methods in surface studies; Guildford, Surrey, UK (10 Jul 1972).

Surface interactions of iodine at low partial pressure with Fe_3O_4 at high temperature were studied because of interest in the mechanism that determines the transport and retention of fission-product iodine in the coolant circuits of high-temperature gas-cooled reactors. The distribution of iodine on Fe_3O_4 powder was studied as a function of the initial coverage and the temperature during adsorption. The two experimental techniques used were a pseudo-isopiestic method to expose Fe_3O_4 at high temperature to radioactive labeled gaseous iodine and thermodesorption to investigate the desorption of the adsorbed iodine into vacuum. Experiments were performed with iodine-loaded Fe_3O_4 samples with 4 different initial coverages at 250°C, then heated to 350° or 450°C. Results indicate that the temperature at the maximum desorption rate becomes independent of the initial coverage (of Fe_3O_4 with adsorbed iodine) and point to a first-order desorption process. Re-adsorption of desorbing iodine or its re-distribution on the surfaces during desorption experiments was negligible. Energy spectra are given. (J.G.B.)

52954 (NIM-1439) REACTION OF SULPHIDE MINERALS WITH THIOL COMPOUNDS. Goold, L. A. (National Inst. for Metallurgy, Johannesburg (South Africa)). 29 Jun 1972. 9p. Dep. NTIS (U. S. Sales Only).

A selected group of thiol reagents was reacted with a wide range of sulfide minerals including molybdenite for extraction of molybdenum, and products that were formed at the surface were extracted and identified by infrared spectrophotometry. Only pyrite oxidized the thiol reagent. With all other sulfide minerals for which reactions took place, the metal thiolate was formed at the mineral surface. These results agree with predictions from rest-potential measurements. (auth)

52955 (RT/CHI-(72)4) THERMOCHEMICAL REACTIONS BETWEEN ALKALINE HALIDES AND OXIDE IMPURITIES IN U_3O_8 MATRIX. Boniforti, R.; Ciancia, A.; Di Giorgio, G. (Comitato Nazionale per l'Energie Nucleare, Rome (Italy)). 21 Mar 1972. 46p. Dep. NTIS (U. S. Sales Only).

The action mechanism of alkali metal halides in the carrier distillation process was studied. The temperature data in the anodic charge allow the alkali metal halide carriers to be considered as melted; a solvent action of the carrier salt in respect to the oxide impurities containied in the U_3O_8 matrix is supposed. The possibility of some thermochemical reactions in the anodic cup was evaluated; the reaction products, formed during arcing, were identified by x-ray diffraction analysis. The x-ray diffraction data and the thermodynamic calculations generally are in rather good agreement. (auth)

52956 EARLY TRANSITION METALS. Kepert, D. L. New York; Academic Press Inc. (1972). 506p. $25.00.

Titles of the four chapters are: general properties of the early transition metals; group IV—titanium, zirconium, and hafnium; group V—vanadium, niobium, and tantalum; and, group VI—chromium, molybdenum, tungsten. References (2445), author and subject indexes are also included. (J.G.B.)

52957 CONTROLLED-POTENTIAL AND CONTROLLED-CURRENT CYCLIC VOLTAMMETER (25 Mar 1969) (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-1653). 6 drawings.

This voltammeter is used in investigations of the electrochemical properties of molten-salt systems. The instrument operates in either the controlled-potential or controlled-current mode. In the controlled-potential mode it is used for linear-sweep voltammetry or chronoamperometry, and in the controlled-current mode for chronopotentiometry with control of the initial potential. (6 drawings) (For details see TID-4100 Suppl. 72) (F.S.)

Isotope Effects

Refer also to abstracts 52990 and 53009.

52958 (UR-3490-193) QUENCHING OF TYROSINE AND TRYPTOPHAN FLUORESCENCE BY H_2O AND D_2O. McGuire, Robert; Feldman, Isaac (Rochester Univ., N. Y. Dept. of Radiation Biology and Biophysics). 1971. 19p. Dep. NTIS.

The quantum yields and lifetimes of the fluorescence of tyrosine and tryptophan were determined in D_2O-H_2O and glycerol-H_2O solvent mixtures of varying composition from 10 vol.% to 100% H_2O at 15°C. For both amino acids the ratio of the quantum yields in D_2O and H_2O (i.e., q_D/q_H) was smaller than the ratio of the corresponding lifetimes (τ_D/τ_H). For tyrosine the ratio of the quantum yields in glycerol and H_2O (q_G/q_H) was also smaller than the corresponding τ_G/τ_H ratio, but for tryptophan $q_G/q_H \cong \tau_G/\tau_H$. The proximity of the q vs τ plots for tyrosine in the two solvent mixtures indicates that at 15°C neither D_2O nor glycerol, in the pure state or when diluted with H_2O, quenches tyrosine significantly. However, H_2O quenches tyrosine by a dynamic process, which increases both the radiative and the nonradiative rate constant. The quenching action is attributed to a tyrosine-H_2O exciplex, whose formation is independent of bulk viscosity and dielectric constant. Unlike tyrosine, tryptophan is quenched weakly by D_2O by a static process at 15°C, but H_2O quenches tryptophan much more efficiently by a dynamic process, which involves the nonradiative rate constant, but not the radiative constant. (auth)

52959 THEORETICAL STUDIES OF HYDROGEN KINETIC ISOTOPE EFFECTS. Schneider, Mary Elizabeth. New York,; Yeshiva Univ. (1971). 148p. University Microfilms Order No. 72-21,748.

Thesis.

Theoretical studies of hydrogen kinetic isotope effects were carried out with particular emphasis on the development of methods of analysis for the interpretation of experimental kinetic-isotope-effect data. Theoretical "exact" isotope-effect data are obtained by computer using a statistical-mechanical expression developed by Bigeleisen. "Exact" model-reaction calculations are used to determine the lower limit to the Arrhenius pre-exponential factors, A_Q, for primary hydrogen kinetic isotope effects in the harmonic approximation and in the absence of quantum mechanical tunneling. Attempts are made to force the A_Q values as low as possible solely through adjustments in the force constant changes, at the isotopic positions, between reactants and transition states. Values of A_Q lower than ~0.7 could not be achieved without making the models so mechanistically unreasonable as to render the results meaningless. This result is in excellent agreement with a prediction made by Bell on the basis of a less rigorous theoretical treatment and lends support to the common practice of interpreting experimental values of A_Q significantly lower than 0.5 as due to the operation of tunneling in the reactions. A method of using Arrhenius pre-exponential factors for secondary hydrogen kinetic isotope effects as sources of information in the elucidation of mechanisms of chemical reactions is developed. The Arrhenius intercepts associated with the individual force constant changes, from reactant to transition state at the isotopic position(s), occurring in a model reaction are found, under certain conditions, to be additive to give the intercept associated with the overall reaction. The same type of additivity is valid for the quantum mechanical contribution to the kinetic isotope effect. These additivity relationships provide a basis for a systematic method of determining force fields for real reaction systems through a combination of experimental measurements and model calculations. It is shown theoretically that low-magnitude, primary, hydrogen kinetic isotope effects may be characterized by the same types of temperature-dependence irregularities that were previously found to be expected fairly commonly for secondary hydrogen isotope effects and primary heavy-atom isotope effects. (Diss. Abstr. Int., B)

52960 MICROWAVE SPECTRUM AND RING-BENDING VIBRATION OF 3-OXETANONE. Gibson, James S.; Harris, David O. (Univ. of California, Santa Barbara). J. Chem. Phys.; 57: No. 6, 2318-28(15 Sep 1972).

The microwave rotational spectrum of 3-oxetanone was observed and assigned for the ground vibrational state, the first five excited states of the ring-bending vibrational mode, and the two carbon-13 isotopically substituted species. The features of the microwave spectrum indicate that the molecule has a single-minimum ring-bending vibrational potential and consequently a planar equilibrium configuration. Approximate models for the ring-bending vibrational mode were set up and the vibrational potential function interpreted in terms of contributions from ring-angle deformations and torsional interactions. The ^{13}C data were used to derive a partial substitution structure. Stark effect measurements yielded the dipole moment as 0.887 ± 0.005 D for the common isotopic species in the ground vibrational state. (auth)

52961 HYDRIDE ION TRANSFER AND ISOTOPE EFFECTS IN CD_4-SILANE ION MOLECULE REACTIONS. Stewart, G. W.; Henis, J. M. S.; Gaspar, P. P. (Monsanto Co., St. Louis). J. Chem. Phys.; 57: No. 6, 2247-8(15 Sep 1972). (COO-1713-29).

Hydride ion transfer is identified as an important mechanism in the reactions of methane and deuterated methane primary ions with silane. The pathway for these reactions is shown not to involve the production of a long-lived intermediate. However, it is shown that additional reactions proceeding through a long-lived intermediate show relatively little isotopic scrambling. Furthermore, it appears that the probability of losing a H atom is very much higher than that for losing a D atom from such an intermediate. (auth)

52962 HOT ATOM REACTIONS IN THE HBr–Br_2, DBr–Br_2 SYSTEMS. White, John M. (Los Alamos Scientific Lab., N. Mex.); Su, H. Y. J. Chem. Phys.; 57: No. 6, 2344-9(15 Sep 1972).

Reactions of photochemically generated hot hydrogen atoms were studied in HBr–Br_2 systems at 185 and 229 nm and in DBr–Br_2 systems at 185 nm. Kinetic analysis furnishes k_3/k_2, the rate coefficient ratio for the reactions, $H^* + Br_2 \xrightarrow{3} HBr + Br$ and $H^* + HBr \xrightarrow{2} H_2 + Br$. At 185 nm for HBr, $k_3/k_2 = 4.11 \pm 0.16$, while at 229 nm $k_3k_2 = 5.48 \pm 0.22$. For DBr at 185 nm the ratio is 5.07 ± 0.12. Complementary trajectory calculations were performed on a semiempirical potential energy surface. The results of these calculations suggest that the observed variations in k_3/k_2 arise primarily because the reaction cross section for Process (3) varies strongly with energy in the hot atom regime and is different for the HBr and DBr systems. (auth)

52963 VARIABLE TRAP PROBLEM IN ISOTOPIC MIXED CRYSTALS OF s-TRIAZINE. Fischer, Gad (Australian National Univ., Canberra). J. Chem. Phys.; 57: No. 7, 2646-52 (1 Oct 1972).

Theoretical treatments of isotopic mixed crystals, in general, assumed that the intermolecular interactions are equal and that the problem can be reduced to a consideration of the free molecule excitation energies. It is shown that for the isotopic s-triazines the intermolecular interactions are different and that now it is necessary to consider a trap depth that is both concentration and distribution dependent. This necessitated a modification of existing theories. Experimental results were obtained over the entire concentration range for the s-triazine$_{d-0}$/s-triazine$_{d-3}$ mixed crystal system, and the results are qualitatively explained in terms of a concentration dependent trap depth. (auth)

52964 KINETICS OF PROTON TRANSFER TO CYANINES. A TEMPERATURE-JUMP STUDY. Dynes, Paul J.; Chapman, Gretchen S.; Kebede, Eshetu; Schneider, Friedemann W. (Univ. of Southern California, Los Angeles). J. Amer. Chem. Soc.; 94: No. 18, 6356-63(6 Sep 1972).

A linear free energy type relationship has been obtained between the logarithm of the measured protonation rate constants of a number of substituted 2,2′-cyanines and the change in π-electron delocalization energies as a consequence of protonation. The absolute values of all rate constants measured by the T-jump technique are five to seven orders of magnitude below diffusion controlled indicating that protonation occurs on the methine carbon. Proton-transfer rate constants to the carbon from second acid-base pairs have Brønsted plots that are strongly unsymmetrical about $\Delta pK = 0$ showing saturation behavior at negative ΔpK values. Activation energies for proton transfer to pseudo-isocyanine are between 8 and 9 kcal/mol, and entropies of activation are strongly negative leading to relatively low Arrhenius factors. Solvent isotope effects measured as a function of temperature for proton transfer involving acetic acid and pseudo-isocyanine are large (~6). Kinetic salt effects support our assignment of relaxation times. Measurements in methanol–water solvents of varying dielectric constants suggest that the effective reaction distance for proton transfer may be relatively short. Thermodynamic parameters for proton transfer involving pseudo-isocyanine are presented. (auth)

52965 H_2BH_3 AS AN INTERMEDIATE IN TETRAHYDRIDOBORATE HYDROLYSIS. Kreevoy, M. M.; Hutchins, J. E. C. (Univ. of Minnesota, Minneapolis). J. Amer. Chem. Soc.; 94: No. 18, 6371-6(6 Sep 1972).

The rate law corresponding to a simple, rate-determining, proton transfer fails to correlate rates of BH_4^- hydrolysis in basic solutions. A rate law arising from a mechanism involving an intermediate which can react with OH^- to regenerate BH_4^- successfully correlates all the observed rate constants. Under appropriate conditions BH_4^- exchanges hydrogen isotopes with the solvent. The exchange rate appears to be about half the rate of regeneration of BH_4^- from the intermediate. These observations strongly suggest an intermediate of composition BH_3 but with the added proton equivalent to only one of the original four. (auth)

52966 POTENTIAL FUNCTION FOR THE RING PUCKERING VIBRATION OF B_2H_6 AND B_2D_6. Pringle, W. C. Jr.; Meinzer, A. L. (Wesleyan Univ., Middletown, Conn.). J. Chem. Phys.; 57: No. 7, 2920-3(1 Oct 1972).

The v = 1 → 2 transition of the ring puckering mode of B_2H_6 was observed at 389.5 ± 0.5 cm^{-1} and identified on the basis of relative intensity measurements of the rotational fine structure of the overlapped v = 0 → 1 and v = 1 → 2 bands. The band center for the ring puckering fundamental was determined to be 369.3 cm^{-1} utilizing an asymmetric rotor calculation. The potential function for the ring puckering vibration based on the v = 0 → 1 and v = 1 → 2 transitions is $V(X) = 25.25(X^4 + 11.78X^2)$, where X is a reduced coordinate. The band centers for the v = 0 → 1 and v = 1 → 2 bands for B_2D_6 were assigned to the "holes" in the band envelope at 261.3 and 272.6 cm^{-1}, respectively. The rotational fine structure in the bands of the deuterated molecule was not resolved. The potential for the deuterated molecule predicted from a reduced mass model is $V(X) = 15.93(X^4 + 14.71X^2)$. (auth)

52967 ISOTOPIC MIGRATION EFFECTS OF ALKALINE IONS IN SULFURIC SOLUTIONS. Perie, Michele; Perie, Jacques (Univ., Paris). J. Chim. Phys.; 69: No. 6, 976-81(Jun 1972). (In French).

The differences between the mobilities of $^6Li-^7Li$ and $^{22}Na-^{24}Na$ ions were studied using electrophoresis on glass paper in water–sulfuric acid mixtures with the acid concentration varying between 9 and 95% (by weight). The isotopic effect increased with the sulfuric ion concentration until a maximum was reached (>0.02 for $^6Li-^7Li$) at a concentration of about 60%. This high value, which is similar to that obtained with molten salts, is probably due essentially to exchange equilibrium effects occurring between the free and associated cations. The diminution of the isotopic effect with H_2SO_4 concentrations greater than 70% may be interpreted by a different structure of the migration medium. (France)

52968 RAMAN SPECTRA OF MOLECULAR CRYSTALS: AMMONIA AND 3-DEUTERO-AMMONIA. Binbrek, O. S.; Anderson, A. (Univ. of Waterloo, Ont.). Chem. Phys. Lett.; 15: No. 3, 421-7(15 Aug 1972).

Raman and infrared spectra of polycrystalline samples of NH_3 and ND_3 were recorded at temperatures between 18 and 107°K. Features from metastable phases are identified, and assignments for the lattice and internal modes of the cubic crystals are proposed. (auth)

52969 MOLECULAR g-VALUE, MAGNETIC SUSCEPTIBILITY ANISOTROPY, MOLECULAR QUADRUPOLE MOMENT, AND SIGN OF THE ELECTRIC DIPOLE MOMENT IN CHLOROACETYLENE. Allen, W. C.; Flygare, W. H. (Univ. of Illinois, Urbana). Chem. Phys. Lett.; 15: No. 3, 461-4(15 Aug 1972).

The high-field molecular Zeeman effect was examined in $^{35}ClC_2H$ and $^{37}ClC_2H$ yielding the molecular g-values, $^{35}g_\perp = -0.00630 \pm 0.00014$ and $^{37}g_\perp = -0.00601 \pm 0.00008$; the magnetic susceptibility anisotropy, $(\chi_\parallel - \chi_\perp) = (9.3 \pm 0.5) \times 10^{-6}$ erg/G^2 mole; the quadrupole moment, $Q_\parallel = (8.8 \pm 0.4) \times 10^{-26}$ esu cm^2, and the electric dipole moment sign of $-ClC_2H+$. (auth)

52970 TEMPERATURE DEPENDENCE OF THE HYPERFINE INTERACTIONS OF Eu^{2+} IN $SrCl_2$. Utley, H. B.; Mahendroo, P. P. (Texas Christian Univ., Fort Worth). Chem. Phys. Lett.; 15: No. 5, 553-4(1 Sep 1972).

ESR spectra of enriched $^{151}Eu^{2+}$ and $^{153}Eu^{2+}$ in a host lattice of $SrCl_2$ were observed at 9.3 GHz over the temperature range of 10 to 300°K. From the EPR spectra the Eu^{2+} hyperfine coupling constants and the Debye temperature were obtained. (auth)

52971 RAMAN SPECTRA OF ORTHORHOMBIC AND CUBIC HYDROGEN AND DEUTERIUM CHLORIDES AT TEMPERATURES ABOVE 80°K. Heastie, R. (Univ. of Waterloo, Ont.). Chem. Phys. Lett.; 15: No. 4, 613-16(1 Sep 1972).

Raman spectra of orthorhombic and cubic HCl and DCl and of liquid HCl were recorded. The significance of the measurements is discussed. (auth)

52972 OBSERVATION AND CALCULATION OF A POSITION DEPENDENT DEUTERIUM EFFECT ON THE TRIPLET LIFETIME OF ANTHRACENE-d_4. Charlton, James L.; Henry, Bryan R. (Univ. of Manitoba, Winnipeg). Chem. Phys. Lett.; 15: No. 3, 369-72(15 Aug 1972).

The lifetimes of anthracene, 1,4,5,8-anthracene-d_4 and 2,3,6,7-anthracene-d_4 were measured. The observed position dependent deuterium effect was theoretically accounted for. (auth)

Isotope Exchange and Isotope Separation

Refer also to abstracts 52996, 53052, and 53088.

52973 EFFECT OF VIBRATIONAL ANHARMONICITY ON HYDROGEN–DEUTERIUM EXCHANGE EQUILIBRIA INVOLVING AMMONIA MOLECULES. Bron, J.; Wolfsberg, Max (Univ. of California, Irvine). J. Chem. Phys.; 57: No. 7, 2862-9(1 Oct 1972).

The anharmonicity correction to the zero-point energy of isotopic ammonias was theoretically evaluated. The G_0 term, usually ignored, makes a significant contribution to this correction. Comparison of the corrections leads to the conclusion that the anharmonicity corrections to the isotopic self-exchange equilibria among the ammonias are negligible. Other correction factors to the self-exchange equilibrium constants calculated in the usual harmonic approximation are also considered and found to be quite negligible. The calculated self-exchange equilibrium constants were compared with experiment and good agreement found. Agreement was also found between theory and experiment for the isotopic exchange equilibrium constant between ammonia and hydrogen. (auth)

52974 ISOTOPIC EXCHANGE BETWEEN SOLID SILVER IODIDE AND IODINE IN p-CYMENE SOLUTION. Sugier, Henryk (Technical Univ., Lodz, Poland). Nukleonika; 17: No. 3-4, 205-6(1972).

The isotopic exchange between solid silver iodide and iodine in p-cymene solutions was studied in the temperature range 90°C to 190°C. It was found that at the temperature of $\beta-AgI \rightarrow \alpha-AgI$ phase change the rate constant of exchange increases by the factor of 13.5 but below and over this point it does not depend on the temperature. (auth)

52975 PRODUCTION OF HYDROGEN FOR DEUTERIUM EXTRACTION. Dirian, Gregoire; Leger, Daniel; Pauly, Jean (to Commissariat a l'Energie Atomique). French Patent 2,098,623. 10 Mar 1972. Filed 22 Jul 1970. (In French).

Water vapor is passed over a metal in the bulk state (Fe, Ni, or Cr), which reduces the water to hydrogen. The hydrogen formed is sent to a plant that extracts the deuterium. The metal is then regenerated by the deuterium-depleted hydrogen. Reduction of the water vapor and the regeneration of the metal are effected in two adjacent tubes. Heat exchange occurs between these tubes, a sensibly constant temperature being established in these tubes. The metal is brought to a temperature between 600 and 900°C. (France)

Feed Materials Processing

Refer also to abstract 53148.

52976 (IEA-250) PREPARATION OF CLEAR URANYL NITRATE SOLUTION BY FRACTIONAL DISSOLUTION OF SODIUM DIURANATE. Abrao, Alcidio; Franca, J. M. Jr. (Instituto de Energia Atomica, Sao Paulo (Brazil)). Nov 1971. 8p. (CONF-680571-1). Dep. NTIS (U. S. Sales Only).

From Materials technology: an inter-American approach conference; Sao Paulo, Brazil (May 1968).

A procedure for preparation of clear uranyl nitrate solutions by fractional dissolution of crude sodium diuranate (SDU) is described. The raw SDU used is obtained by industrial processing of monazite sand and contains some thorium, rare earth elements, iron, silicon and phosphorus as main impurities. With the procedure described, clear and stable uranyl nitrate solutions having 270 to 300 g/l U and exhibiting good filtration characteristics are obtained. The procedure allows a satisfactory removal of thorium, rare earth elements, phosphorus, silicon, and iron. (auth)

52977 NUCLEAR FUELS AND FUEL PROCESSING. Johari, S. S.; Bhandari, D. R. (Univ. of Jodhpur, India). Mfg. Eng.; 1: No. 4, 22-32(Jan 1971).

Extraction of thorium and uranium metal from their ores is outlined with a note on machining of materials. Three processes, solvent extraction, fluoride volatility, and oxidative slagging for fuel reprocessing, are described in detail giving the principle, procedure, advantages and disadvantages, etc. Four methods for enrichment of the fuel, gaseous diffusion process, thermal diffusion, electromagnetic method, and centrifugation, are briefly described. A short note is given on the separation of ^{233}U from thorium. (INIS)

Radiation Chemistry

Refer also to abstracts 52962, 54996, and 55018.

52978 (CEA-N-1528) PHOTOLYSIS AND RADIOLYSIS OF NITROMETHANE IN THE LIQUID PHASE. Tran-Dinh-Son (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Jun 1972. 119p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Paris Univ., Orsay, France.

The physical and chemical properties of nitromethane are summarized. The reaction of this substance with methyl radicals was studied by observing the reduction of CH_4 and C_2H_6 formed during the photolysis of acetone in aqueous nitromethane solutions of different concentrations. The photolysis and radiolysis of pure liquid nitromethane are described. All the products produced were analyzed and the existence of an important after-effect, which affects the yields of some of these products was demonstrated. The mechanisms responsible for the formation of all of these products are discussed. The differences between the reactions undergone by the ions and the primary radicals enabled the contributions of each type of dissociation to the radiolysis to be estimated. (France)

52979 (COO-1105-179) SOME PRELIMINARY PARAMAGNETIC RESONANCE STUDIES FOR DOSIMETRY RESEARCH. Fuller, G. E.; Leach, R. K.; Moran, P. R.; Fitzsimmons, W. A. (Wisconsin Univ., Madison. Dept. of Physics). [nd]. 12p. Dep. NTIS.

Paramagnetic resonance studies were made of some compounds that have potential application at room temperature as low radiation level dosimeters. Radioinduced radicals in arsenate-doped ammonium dihydrogen phosphate gave large ESR signals. The radiation yield, recombination rates, spin-lattice relaxation times, and EPR lineshapes of H atoms produced by 160-keV electron bombardment of solid H_2 in the temperature range from 1.4 to 8°K were measured. The estimated yield of 0.2 H atoms per 100 eV of ionizing radiation for low concentrations was in reasonable agreement with other experiments. (M.C.G.)

52980 (COO-3461-1) STUDY OF THE PULSE RADIOLYSIS OF GASES. Final Report. Dondes, S.; Harteck, P.; Carr, T.; Haskell, R. (Rensselaer Polytechnic Inst., Troy, N. Y.). 15 Sep 1972. Contract AT(30-1)-3821. 25p. Dep. NTIS.

The pulse radiolysis of gases and direct determination of short-lived species having lifetimes on the order of nanoseconds and longer are reported. This study is important in the determination of mechanisms and kinetics in radiation chemistry. At the inception of this work, emphasis was placed on experiments involving the wavelength range from about 2000 to 8000 angstroms, light focusing devices, elimination of noise and gamma flash interference within the signal, cell design, shielding, etc. Short-lived species were produced by the injection of high energy electrons from a 1-MeV van de Graaff Accelerator into various gaseous systems at pressures of about 20 atmospheres. Their presence was determined by analysis of their emission spectra. Lifetimes of the species, such as NO(γ) bands and NH bands, were determined using, single (0.5×10^{-6} second) pulse techniques on nitrogen-oxygen, nitrogen-nitric oxide, and helium-nitrogen mixtures. This area of the work indicated that a redesign of the Van de Graaff Electron Accelerator to produce 1×10^{-9} second pulses was necessary to determine the lifetimes of such species as the N_2^+ first negative bands, the N_2 second positive bands, etc. The available pulse widths are 1, 3, 10, 30, and 100 nanoseconds. (Changes in the Van de Graaff Electron Accelerator were enumerated in RPI-3821-5.) Use of the 1, 3, 10 and 30 nanosecond electron pulses in lifetime determinations of the N_2^+ first negative and N_2 second positive band systems was studied. The N_2 second positive band system was studied in pure nitrogen, helium-nitrogen and argon-nitrogen mixtures. The N_2^+ first negative band system was studied in helium-nitrogen mixtures. The observed radiative lifetimes for the N_2 second positive band system in pure nitrogen, Ar-0.5% N_2 and He-0.1% N_2 are 11.76, 12.23, and 13.66 nanoseconds, respectively. The observed lifetime of the N_2^+ first negative band system was found to be 18.69 nanoseconds. (auth)

52981 (COO-3571-3) RELATION BETWEEN SINGLE-STRAND DNA MASS AND SEDIMENTATION DISTANCE IN ALKALINE SUCROSE GRADIENTS. Levin, David; Hutchinson, Franklin (Yale Univ., New Haven, Conn. Dept. of Molecular Biophysics and Biochemistry). 1972. 21p. Dep. NTIS.

Single-strand breaks were introduced into T2 and B. subtilis DNA in dilute solution with gamma rays and the DNA sedimented on alkaline sucrose gradients. Assuming the number of single-strand breaks is linear with dose and the distance sedimented in alkaline sucrose gradients D is proportional to M^{α} (M is the single-strand DNA mass), the value of α was determined to be 0.40. (auth)

52982 (EUR-4765, pp 11-24) IONIC CHEMISTRY OF GASEOUS cC_6H_{12}. Cosandey, M.; Giardini, A.; Zocchi, F. (CNEN, Rome. Univ., Rome).

From 2nd conference on mass spectrometry; Ispra, Italy (1 Sep 1971).

Mass spectrometric studies were conducted on ion-molecule reactions in pure cyclohexane and in mixtures of cyclohexane and NH_3 and NO. The effects of small variable concentrations of several gases, including CO_2, SF_6, CO, N_2O, O_2, C_2H_2, and H_2O, on the ionic distribution in cyclohexane were also studied. Mechanisms for reactions within the systems are proposed and confirmed by comparison of results with those from γ-radiolytic studies on cyclohexane and cyclohexane-ND_3 mixtures. (J.G.B.)

52983 (EUR-4828) STUDY BY DIFFERENTIAL ABSORPTION IN INFRARED OF IRRADIATED LIPIDS AND POLYMERS.

Deschreider, A. R. (Ministere des Affaires Economiques, Brussels (Belgium)); Vigneron, J. M. (Centre National d'Assistance Technique et de Recherche Appliquee, Antwerp (Belgium)). 1972. 32p. (In French). Dep. NTIS (U. S. Sales Only).

In the case of examination by infrared spectrophotometry of gamma-irradiated substances, the differential absorption curves allow elimination of the difficulty of interpretation of normal infrared spectra. This technique was applied to irradiated frozen eggs, animal fats, and plastic packaging materials for foods. In all the cases, differential absorption bands were observed coming from typical frequential groups and, in particular for the irradiated polymers, their number was a function of the applied dose. (auth)

52984 (FRNC-TH-262) RADIATION EFFECTS ON IONIC AND MOLECULAR CRYSTALS. Dimitropoulos, Constantin (Universite Scientifique et Medicale de Grenoble (France)). 1972. 109p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

The experimental techniques (nuclear quadrupole resonance, electron spin resonance, double resonance, optical spectroscopy, mass spectroscopy, chromatography) and the irradiation procedures used at high and low temperatures are described. $NaClO_3$ and paradichlorobenzene crystals exposed to γ and x radiations at 78°K, and paradichlorobenzene samples irradiated under different conditions (gamma rays, neutrons, dose rates, controlled atmosphere) at temperatures greater than the melting point were studied. The results obtained are discussed. (France)

52985 (NASA-TM-X-2440, pp 584-94) MICROSCOPIC OBSERVATION OF X-RAY AND γ-RAY-INDUCED DECOMPOSITION OF AMMONIUM PERCHLORATE CRYSTALS. Herley, P. J. (Picatinny Arsenal, Dover, N. J.); Levy, P. W. Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

The x-ray- and γ-ray-induced decomposition of ammonium perchlorate (a commonly used oxidizer in solid propellents) was studied by optical, transmission, and scanning electron microscopy. In some respects the radiation-induced damage closely resembles the effects produced by thermal decomposition, but in other respects the results differ markedly. Similar radiation and thermal effects include the following: (a) irregular or ill-defined circular etch pits are formed in both cases; (b) approximately the same size pits are produced; (c) the pit density is similar, namely ~2 to $40 \times 10^6/cm^2$; (d) the c face is considerably more reactive than the m face; and (e) most importantly, many of the etch pits are aligned in crystallographic directions which are the same for thermal or radiolytic decomposition. Thus, dislocations play an important role in the radiolytic decomposition process. Radiolytic decomposition produces at least three effects not previously observed with ammonium perchlorate: (a) after 10^8 rad γ-ray irradiated crystals effervesce during solution in water; (b) the initial x-ray and γ-ray induced decomposition sites occur throughout the volume where energy is deposited. Once formed they continue to grow. In contrast, the initial thermal pits appear at the surface and grow. New pits are formed as the reaction zone proceeds inward; (c) x-ray irradiation produces highly strained crystals. The layer adjacent to the irradiated surface becomes extensively cracked and large crystals have pronounced convex curvature. Inasmuch as the principal decomposition is restricted to certain crystallographic sites, highly mobile energy transfer mechanisms must play an important role in the radiolytic decomposition and ammonium perchlorate. Most likely, the transfer agents are electrons, holes, excitons, or possibly protons. (auth)

52986 (ORNL-4794, pp 98-101) MISCELLANEOUS PROGRAMS. Aug 1972.

In Chemical Technology Division annual progress report for period ending March 31, 1972.

Research progress is reported on: quality assurance program, evaluation of the radiation resistance of selected protective coatings, resource studies, and environmental impact of nuclear power reactors and chemical reprocessing plants. (D.H.M.)

52987 (ORO-2968-78) RESEARCH CONCERNING IONIC AND FREE RADICAL REACTIONS IN RADITATION CHEMISTRY. Progress Report, September 15, 1971-August 15, 1972. Williams, T. Ffrancon (Tennessee Univ., Knoxville. Dept. of Chemistry). 1972. Contract AT(40-1)-2968. 106p. Dep. NTIS.

Research progress is reported on intermediate species produced in γ-irradiated organic and inorganic compounds at low temperatures and on ESR studies of radical trapping in the radiolysis of organic liquids. Project summaries are given with references to published work. Separate abstracts were prepared for 4 "in press" papers attached. (M.C.G.)

For abstracts of individual papers see: 52988-52991.

52988 (ORO-2968-78, Paper 2) ELECTRON SPIN RESONANCE STUDIES OF RADICAL TRAPPING IN THE RADIOLYSIS OF ORGANIC LIQUIDS. I. EVIDENCE FOR THE PRIMARY FORMATION OF THE METHOXY RADICAL IN METHANOL. Wargon, Jorge A.; Williams, Ffrancon. 1972. 9p.

In Research concerning ionic and free radical reactions in radiation chemistry.

Utilization of the spin trapping technique is reported in resolution of the problem of primary radical formation in the γ radiolysis of deaerated liquid methanol. Results indicated that the methoxy radical is the most abundant primary radical formed. (M.C.G.)

52989 (ORO-2968-78, Paper 4) INVESTIGATION OF THE STRUCTURE OF THE HYDRATED ELECTRON BASED ON UNPAIRED ELECTRON DENSITIES CALCULATED BY THE INDO METHOD. Kerr, Carolyn M. L.; Williams, Ffrancon. 1972. 19p.

In Research concerning ionic and free radical reactions in radiation chemistry.

Spin density distributions were calculated for a number of possible structures for the hydrated electron, and the total spin density associated with the hydrogen atoms compared with the value derived from ESR experiments. Although the agreement with experiment was not close, the best results were obtained for a planar dimeric structure containing two central hydrogens close to one another. The structure of the hydrated electron may incorporate symmetrically placed units of this type. (auth)

52990 (ORO-2968-78, Paper 5) HYDROGEN ATOM ABSTRACTION BY METHYL RADICALS IN METHANOL GLASSES AT 67 TO 77°K. Campion, Alan; Williams, Ffrancon. 1972. 20p.

In Research concerning ionic and free radical reactions in radiation chemistry.

It was shown by ESR studies that the thermal decay of $CH_3\cdot$ radicals in a methanol-d glass at 77°K proceeds with the concomitant formation of the $\cdot CH_2OD$ radical. The reaction obeys first-order kinetics over 75% of its course and there is reasonably good agreement between the rate constants as determined from $CH_3\cdot$ decay and $\cdot CH_2OD$ growth. At 77°K, the rates of H-atom abstraction by $CH_3\cdot$ from CH_3OD and CH_3OH are comparable but the rate of $CH_3\cdot$ decay in CD_3OD is slower by at least a thousandfold. This primary deuterium isotope effect confirms that abstraction occurs almost exclusively from the hydrogens of the methyl group. The apparent activation energy of 0.9 kcal mol^{-1} for the abstraction reaction in the glassy state at 67 to 77°K is much lower than the value of 8.2 ± 0.2 kcal mol^{-1} previously reported for essentially the same reaction in the gas phase above 376°K. These findings are similar to those reported for H-atom abstraction by $CH_3\cdot$ radicals from acetonitrile and methyl isocyanide, and are consistent with the proposal that these reactions proceed mainly by quantum-mechanical tunneling at low temperatures. (auth)

52991 (ORO-2968-78, Paper 6) ESR STUDIES OF ALIPHATIC RADICAL ANIONS AND RADICAL-ANION PAIRS IN γ-IRRADIATED CRYSTALLINE SOLIDS. Bonin, M. A.; Chung, Y. J.; Sprague, E. D.; Takeda, K.; Wang, J. T.; Williams, F. 1972. 19p.

In Research concerning ionic and free radical reactions in radiation chemistry.

ESR studies on γ-irradiated acetonitrile, adiponitrile, succinonitrile, acrylonitrile, tert-butyl isocyanate, and tert-butyl isothiocyanate crystals are reported. Reactions of the radical anions and radical-anion pairs are summarized. (M.C.G.)

52992 (RFP-1924) THERMAL AND RADIATION STABILITY OF POLYVINYL CHLORIDE. Kazanjian, A. R.; Horrell, D. R. (Dow Chemical Co., Denver, Colo. Rocky Flats Div.). 1 Sep 1972. Contract AT(29-1)-1106. 6p. Dep. NTIS.

A study was made of the thermal and radiation stability of the poly(vinyl chloride) bags used for plutonium storage at Rocky Flats. The poly(vinyl chloride) (PVC) was subjected to temperatures of 98 to 140°C, and gamma radiation up to doses of 2.1×10^6 rads. It was found that radiation and heat, applied together, significantly lowered the physical strength of the PVC, whereas applied individually to the same levels the effects were negligible. Oxygen in air was shown to be necessary for a rapid rate of degradation. It was estimated that the PVC bags could be used for almost indefinite storage periods under the usual conditions (i.e., less than 98°C and very low radiation doses) at Rocky Flats. (auth)

52993 (RRL-3238-398) QUARTERLY REPORT, APRIL 1, 1972-JUNE 30, 1972. Fundamental Research No. 6041. (Mellon Inst. of Science, Pittsburgh, Pa. Radiation Research Labs.). 27 Jul 1972. Contract AT(11-1)-3238. 17p. Dep. NTIS.

Research progress is reported on ESR spectra of radiolytic radicals and other radiation chemistry studies. Journal publications are listed and abstracts of reports issued are included. (M.C.G.)

52994 PEROXIDATION OF POLYMETHYLHYDROGENSILOXANE AND CELLULOSE BY γ-IRRADIATION IN AIR AND GRAFTING INDUCED BY THEIR DECOMPOSITION. Shimizu, Harumichi (Tokyo Metropolitan Isotope Research Center). J. Nucl. Sci. Technol. (Tokyo); 9: No. 8, 473-9(Aug 1972).

The peroxides of polymethylhydrogensiloxane, cellulose, and a mixture of both were determined by the ferrous ion method. The relation between the decomposition of the peroxide and the degree of grafting by standing at an elevated temperature after irradiation was examined. The G-value for the peroxide formation of polymethylhydrogensiloxane was found to be 8.7, and the activation energy for the peroxide decomposition was determined from calculation to be 43 kcal/mole. The ratio of G-values of silicone between those terminated by methoxy radical and by methyl radical is estimated to be about 2/1. It would thus appear certain that the rate of peroxidation is affected by the end group. The peroxidation is not a chain reaction at room temperature, and the peroxide is produced by the recombination of the peroxy radical. At least two types of peroxide are produced by irradiation in air, and one is decomposed at 80°C but the other is relatively stable. On the other hand, the G-value for the peroxide formation of cellulose is equal to 5.6. The tendency seen for the decrease of the peroxide corresponds to that of increasing degree of grafting, and it may be concluded that only 1/10 of the peroxides formed in the cellulose–silicone system results in grafting, since it was calculated that the G-value for the grafting through the peroxide is about 1.0. (auth)

52995 ESR STUDY OF AMINO ACID AND PROTEIN-FREE RADICALS IN SOLUTION. IV. AN ESR STUDY OF GAMMA-IRRADIATED AMINO ACIDS IN FROZEN AQUEOUS SOLUTIONS. Hong, Sun Joo; Holmes, D. E.; Piette, L. H. Daehan Hwahak Hwoejee; 15: No. 5, 256-65(1971).

An ESR study was made on free radicals produced in frozen aqueous solutions (ices) of glycine, DL-α-alanine, DL-serine, L-cysteine, DL-leucine, and DL-isoleucine by γ-irradiation at dry ice temperature. All free radicals induced were decayed concomitant to the successive annealing but the radical species which was believed to be dominant seems to be stable even near the melting point of the ice. These dominant species were found to be identical to those resulting from direct action of radiation in the solid at room temperature. Small but significant changes in the spectra of glycine and DL-α-alanine were observed by varying the microwave power. These results seem to support the view that the spectra obtained were a composite of more than two different resonances having different power saturation characteristics. The relative contribution of unidentified resonances to the composite spectra was greater for solutions of low concentration. These resonances are assumed to be induced by indirect effects, mainly hydrogen abstraction by radiation produced hydroxyl radicals and also C–N bond cleavage hydrated electrons. (Korean Sci. Abstr.)

52996 ELECTRON SPIN RESONANCE AND ELECTRON NUCLEAR DOUBLE RESONANCE OF SINGLE CRYSTALS OF DL-SERINE. Castleman, Bruce Wayne. Tallahassee; Florida State Univ. (1972). 151p. University Microfilms Order No. 72-21,303.

Thesis.

The free radicals produced in x-irradiated single crystals of DL-serine in the temperature range 77 to 340°K were identified using ESR and electron nuclear double resonance (ENDOR) techniques. At 77°K the primary products are molecular anions and cations. The DL-serine cation successor has been proposed as the radical $HOCH_2\dot{C}H(NH_3^+)$, produced by decarboxylation, which decays upon warming the crystal to 153°K to the species $HO\dot{C}H(NH_3^+)COO^-$ through an intermolecular hydrogen abstraction. It is proposed that the anion is $HOCH_2\dot{C}H(NH_3^+)COO^{2-}$, which is neutralized by means of proton transfer and becomes $HOCH_2\dot{C}H(NH_3^+)CO^-OH$. At about 153°K this species decays through deamination to the form $HOCH_2\dot{C}HCOOH$, which is stable only in the range 153 to 173°K. Above 173°K this species undergoes a molecular reorientation and persists to room temperature. It then decays at room temperature through two separate paths to yield the species $HO\dot{C}HCH(NH_3^+)COO^-$ and $HOCH_2\dot{C}(NH_3^+)COO^-$, which are stable at room temperature. Irradiation with 3-MeV x rays at 300°K yields initially the species $HOCH_2\dot{C}HCOOH$, which decays as above. Deuterated crystals after irradiation at 300°K undergo hydrogen–deuteron exchanges and eventually yield the species $DOCD_2\dot{C}DCOOD$. An ENDOR spectrometer was constructed and used to identify one of the radical species. A description of the ENDOR system is given. (Diss. Abstr. Int., B)

52997 DECOMPOSITION OF ALDRIN BY GAMMA RADIATION. II. IN LIPID SOLUTIONS. Carp, A. E.; Liska, B. J.; Ziemer, P. L. (Purdue Univ., Lafayette, Ind.). Bull. Environ. Contam. Toxicol.; 7: No. 6, 331-7(1972).

A study was made of the effects of γ irradiation on aldrin dissolved in corn oil and lard by varying conditions used in packing, irradiating, and storing the samples. The only treatment which produced any major alteration of the amounts of the isomers formed was the temperature at which irradiation was accomplished. The chromatographs of the samples irradiated without any temperature control generally showed four peaks, while those irradiated at −196°C showed only three. (D.H.M.)

52998 FORMATION OF ANTIBIOLOGICAL SUBSTANCES BY RADIATION-CHEMICAL REACTION. OCCURRENCE OF ANTIBACTERIAL ACTIVITY AFTER GAMMA IRRADIATION FROM TWO CONSTITUENT MOIETIES OF THE CHLORAMPHENICOL MOLECULE. Tamemasa, Osamu; Goto, Rensuke (Shizuoka Coll. of Pharmacy, Japan). Yakugaku Zasshi; 92: No. 1, 104-8(Jan 1972). (In Japanese).

In order to develop a new molecular species of compounds with antibiological activities by the application of radioinduced reactions, a model experiment was carried out to see whether chloramphenicol would be formed by γ irradiation of some mixtures of nitrobenzene, p-nitrophenol, or p-bromonitrobenzene, and 2-dichloroacetamidopropane-1,3-diol. The results showed that after irradiation of 100 to 200×10^4 R, antibacterial activities against E. coli and St. aureus of only the aqueous mixture of nitrobenzene and 2-dichloroacetamidopropane-1,3-diol were about 4 to 8 times greater than those of each irradiated component or of the mixture of each irradiated component. No formation of chloramphenicol itself was, however, confirmed in the irradiation products by means of paper chromatography, bioautography, radiopaper chromatography, or Sephadex G-10 gel filtration. (auth) (Japan)

52999 RADIATION ABSTRACTION OF HYDROGEN ATOMS IN SINGLE CRYSTALS OF THYMINE. Dulcic, A.; Herak, J. N. (Inst. Rudjer Boskovic, Zagreb). J. Chem. Phys.; 57: No. 6, 2537-40(15 Sep 1972).

Single crystals of both thymine monohydrate and anhydrous thymine were irradiated at 77°K and the radicals induced were analyzed with ESR spectroscopy. The radical species, formed by abstraction of a hydrogen atom from nitrogen, was studied in detail. Molecular orbital calculations suggest that the abstraction takes place from $N_{(1)}$. The nitrogen and the methyl proton coupling tensors are identical in both crystal systems. The g tensor is axially symmetric ($g_{\parallel} = 2.0032$, $g_{\perp} = 2.0064$) with the axis of symmetry perpendicular to the ring plane. The differences between deuterated and undeuterated thymine monohydrate crystals are also discussed. (auth)

53000 FORMATION OF ACETYLENE AND METHANE IN ARGON AND XENON SENSITIZED RADIOLYSIS OF GASEOUS ETHYLENE. Gawlowski, Janusz; Niedzielski, Jan; Sobkowski, Jerzy (Univ., Warsaw). Nukleonika; 16: No. 11-12, 513-21(1971).

The radiation yields of methane and acetylene in argon- and xenon-sensitized radiolysis of gaseous ethylene were determined. $G(C_2H_2)$ and $G(CH_4)$ decreased with increasing argon pressure over the range 50 to 700 torr. $G(C_2H_2)$ was practically independent of the pressure of xenon. Results indicate that in the radiolysis of ethylene some part of the acetylene is formed in ion-molecule reactions, originating with primary vinyl and acetylene ions. Methane is formed predominantly by the dissociation of butyl ions $[C_4H_9^+]^*$. The lifetime of excited butenyl ions is approximately 5 times shorter than that of butyl ones. Charge transfer from acetylene ions to ethylene is unaffected by the changes in the pressure of a rare gas. (auth)

53001 PREPARATION OF ANHYDROUS HYDRAZINE BY THE RADIOLYSIS OF LIQUID AMMONIA. Belloni, Jacqueline Dolores Therese; Fradin de la Renaudiere, Jean Jacques Marie. French Patent 2,087,507. 31 Dec 1971. Filed 21 May 1970. (In French).

A method of preparing pure anhydrous hydrazine by the radiolysis of liquid ammonia with γ rays from ^{60}Co, or a beam of accelerated electrons, is described. The method consists of adding various salts (amide, imide, nitride, or hydride) to the liquid ammonia in order to make its pH basic. The solution is then irradiated. Fractional distillation is used to separate the hydrazine from the synthesizing medium. (France)

53002 SHOULDER OF OPTICAL ABSORPTION SPECTRUM OF THE TRAPPED ELECTRON IN GAMMA-IRRADIATED CRYSTALLINE ICE. Kawabata, Keisuke; Okabe, Shigeru; Taniguchi, Setsuo (Radiation Center, Osaka). J. Chem. Phys.; 57: No. 7, 2855-6(1 Oct 1972).

Precise measurements of the absorption spectrum and its differential of the trapped electron in crystalline ice were made. The absorption spectrum, due to a single kind of trap, has a shoulder around 5000 to 5600 Å, suggesting that it is composed of at least two components. (auth)

53003 PULSE RADIOLYSIS STUDY OF SUCCINONITRILE IN THE ROTATOR PHASE. Campion, Alan (Univ. of Tennessee, Knoxville); Ghormley, John A.; Williams, Ffrancon. Contract AT(40-1)-2968. J. Amer. Chem. Soc.; 94: No. 18, 6301-4(6 Sep 1972). (ORO-2968-71).

A transient absorption spectrum ($t_{\frac{1}{2}}$ = 0.23 μsec) was detected in the pulse radiolysis of succinonitrile, a plastic crystal at room temperature. This absorption is not produced in the presence of 1 mole % tetracyanoethylene (TCNE) and the spectrum of $TCNE^-$ is observed instead. The value of λ_{max} (450 nm) for the transient corresponds to the absorption maxima observed in the low-temperature spectra of monomer radical anions from acetonitrile and adiponitrile. On the basis of these results, the transient spectrum is assigned to a monomer radical anion of succinonitrile although the possibility of a dimer species similar to that observed at low temperature cannot be excluded. The first-order decay of the radical anion is attributed to the unimolecular dissociation to $\cdot CH_2CH_2CN$ and CN^-. In addition to the radical anion, a long-lived species is produced which absorbs most strongly in the ultraviolet. (auth)

53004 ELECTRON SPIN RESONANCE AND ELECTRON NUCLEAR DOUBLE RESONANCE STUDIES OF DL-SERINE. II. IDENTIFICATION OF FREE RADICALS PRODUCED IN THE RANGE 153 TO 340°K. Castleman, B. W.; Moulton, Grace C. (Florida State Univ., Tallahassee). J. Chem. Phys.; 57: No. 7, 2762-8(1 Oct 1972).

Single crystals of x-irradiated DL-serine, deuterated DL-serine, and α-D-1-DL serine were examined in the temperature range 77 to 340°K using ESR and ENDOR techniques. Six of the radical species observed were identified and the mechanisms by which these species are formed are discussed. The initial species produced at 77°K are the anion and cation radicals that decay through inter- and intramolecular processes and finally form two stable radicals at room temperature. (auth)

53005 ESR STUDY OF AN IRRADIATED SINGLE CRYSTAL OF ACETYLENE DICARBOXYLIC ACID DIHYDRATE. Muto, Hachizo; Toriyama, Kazumi; Iwasaki, Machio (Government Industrial Research Inst., Nagoya, Japan). J. Chem. Phys.; 57: No. 7, 3016-17(1 Oct 1972).

ESR spectra are shown for an irradiated single crystal of acetylenedicarboxylic acid dihydrate measured after irradiation at 77°K in the dark, after annealing at −140°C for 5 min, and after annealing at −90°C for 10 min. (M.C.G.)

53006 PULSE RADIOLYSIS OF LIQUIDS AT HIGH PRESSURES. III. HYDRATED-ELECTRON REACTIONS NOT CONTROLLED BY DIFFUSION. Hentz, Robert R.; Farhataziz; Hansen, Earl M. (Univ. of Notre Dame, Ind.). J. Chem. Phys.; 57: No. 7, 2959-63(1 Oct 1972).

Specific rates of the reactions of e^-_{aq} with hydrogen ion, formamide, acetamide, acetoxime, benzyl alcohol, and 2-chloroethanol were measured by pulse radiolysis at 29°C and six pressures from atmospheric to 6.4 kbar. The specific rates increased monotonically with increases in pressure to 6.4 kbar except that for the H_3O^+ reaction, for which there was no further significant increase above ~3.5 kbar. Results for the H_3O^+ reaction were consistent with that reaction not being diffusion controlled. The activation volume of each reaction increased with increases in pressure. Such a result is attributed to a decrease in cavity volume of the electron with increase in pressure. Activation volumes, in units of milliliters per mole, at 1 atm and 29°C are −2.7, −10.3, −7.0, −9.5, −9.3, and −8.2 for reactions with H_3O^+, formamide, acetamide, acetoxime, benzyl alcohol, and 2-chloroethanol, respectively. Interpretation of the activation volumes gives a partial molal volume of 7 ml $mole^{-1}$ and, with an electrostriction volume of 3 ml $mole^{-1}$, a cavity volume of 10 ml $mole^{-1}$ for the electron in water at 1 atm and 29°C. A previous estimate of $\bar{V}(e^-_{aq})$ = 0 ml $mole^{-1}$, based on study of competitive reactions of e^-_{aq} by γ radiolysis at high pressures, is reconciled with the value of $\bar{V}(e^-_{aq})$ = 7 ml $mole^{-1}$. (auth)

53007 SOLVATION OF ELECTRONS IN 3-METHYLHEXANE AT 77°K. Richards, J. T. (Univ. of Salford, Eng.); Thomas, J. K.; Klassen, N. V.; Gillis, H. A.; Walker, D. C. J. Chem. Phys.; 57: No. 7, 3025-8(1 Oct 1972).

Previous time dependence of the spectra of radiolytic solvated electrons in organic glasses was not observed in the absorption spectra of e^-_t in 3-methylhexane liquid at −78°C, but rather a decay with time of the whole spectrum. Also reported are similar absorption data in propane from 1500 to 1700 nm. (M.G.C.)

53008 POSSIBLE IDENTIFICATION OF Pb^{1+} AND PbH^{2+}: AN ELECTRON PARAMAGNETIC RESONANCE STUDY. Roberts H. C.; Eachus, R. S. (Eastman Kodak Co., Rochester, N. Y.). J. Chem. Phys.; 57: No. 7, 3022-3(1 Oct 1972).

ESR spectra tentatively assigned to Pb^+ and PbH^{2+} were obtained from x-irradiated $Pb(C_2H_3O_2)_2 \cdot 3H_2O$ powders and single crystals at 77°K. The analysis and assignments are based on the observed principal g factors and the detection of hyperfine splittings from the ^{207}Pb isotope. (M.C.G.)

53009 EFFECT OF THE STRUCTURE OF THE SOLID PHASE ON HNO_3 RADIOLYSIS. Kozlowska-Milner, Ewa (Inst. of Nuclear Research, Warsaw). Nukleonika; 17: No. 1-2, 11-22(1972).

A considerable change in ESR spectra (at 77°K) of HNO_3 and DNO_3 frozen under various conditions of crystallization and subjected to γ irradiation in a ^{60}Co source was observed. The spectrum of the acid dispersed in the xenon or chloroform matrices resembles the spectrum of rapidly frozen acid of vitreous structure. A spectrum of a type not hitherto observed was obtained for the acid crystallized slowly at a temperature near the melting point. A far more complex structure of NO_3 and NO_2 signals was observed. In contradiction to previous works it is assumed that in the HNO_3 medium the rotational motion of NO_2, observed in some other systems at 77°K, does not occur, and the g tensor is nonaxially symmetric. Splitting of individual NO_2 signals into doublets, observed for slowly crystallized acid, is presumably due to the interaction of proton through a short hydrogen bond of NO_2 in HNO_3. In nitric acid medium deformation of the NO_3 radical occurs, which is reflected in the full anisotropy of the g tensor. The spectral data for the NO_3 radical are similar to those obtained for urea nitrate. This implies the presence of a hydrogen bond of NO_3 in HNO_3 medium. The triplet structure (splitting of ~3.5 G) of the NO_3 signals is noted. Quantitative evaluation indicates a decrease of the NO_3/NO_2 ratio for the acid rapidly frozen in liquid nitrogen (vitreous structure) or for the acid dispersed in the xenon matrix. These changes are interpreted taking also into account ir data, as an effect of various structure of the associates on the radiolysis of HNO_3. (auth)

53010 RADIOTHERMOLUMINESCENCE OF CYCLOHEXENE. Rybicki, Edward; Kroh, Jerzy (Technical Univ., Lodz, Poland). Nukleonika; 17: No. 1-2, 59-67(1972).

The radiothermoluminescence (RTL) of cyclohexene, its dependence on the absorbed γ dose and the presence of various additives (CH_3OH, CCl_4, C_6H_6), was investigated. Experiments on photobleaching made possible identification of $C_6H^+_{10}$ cations. Results suggest that the recombination of cyclohexene cations and anions plays an important role in RTL of C_6H_{10}. (auth)

53011 HYDROGEN SULFIDE RADIOLYSIS SENSITIZED BY ARGON, KRYPTON, XENON, AND NITROGEN. Jezierska, Krystyna; Forys, Mieczyslaw (Univ. of Warsaw). Nukleonika; 17: No. 1-2, 23-9(1972).

Gaseous mixtures of hydrogen sulfide with argon, krypton, xenon, and nitrogen were subjected to γ radiolysis in a wide range of concentrations. The main role of charge-transfer processes in sensitized radiolysis of hydrogen sulfide is demonstrated. It is shown that a competition between charge transfer to hydrogen sulfide and formation of dimeric ions takes place, which causes the linear dependence of $G(H_2)^s$ on $[R]^2/[H_2S]$ ratio. Charge transfer rate constants were calculated: $k_{Ar^+ + H_2S} = 1.0 \cdot 10^{-10}$ $cm^3/molecules \times s$, $k_{Kr^+ + H_2S} = 2.6 \times 10^{-11}$ $cm^3/molecules \times s$, and $k_{N_2^+ + H_2S} = 1.1 \cdot 10^{-9}$ $cm^3/molecules \times s$. (auth)

53012 RADIATION SULFOXIDATION OF n-PARAFFINS. I. Kowalski, Antoni; Bogus, Wlodzimierz; Perkowski, Jan (Miedzyresortowy Instytut Techniki Radiacyjnej, Lodz, Poland). Nukleonika; 17: No. 1-2, 31-45(1972). (In Polish).

The radioinduced sulfoxidation process was investigated for two fractions of normal paraffins: C_{10} to C_{14} and C_{14} to C_{17} respectively. A critical review of the mechanism of radioinduced sulfoxidation as proposed by different authors is also included. Results of investigations on the following problems are presented: dependence of the rate of sulfoxidation on the purity of paraffins and methods of their purification, the influence of dose rate on reaction rate, relation between the pressure of gaseous reagents and rate of the sulfoxidation process, and the possibility of synthesis when only gases entering the reactor are irradiated. Highest reaction rates were observed with alkanes which were used in previous sulfoxidation experiments. The alkanes available contained some inhibitors of the sulfoxidation process. The reaction yields for the sulfoxidation were about 1200 for alkanes C_{10} to C_{14} and 650 for fraction C_{14} to C_{17}. It was found that the yield of sulfuric acid diminished with an increasing degree of conversion. A very low yield of sulfoxidation products was observed in the case when gases entering the reactor were irradiated but no radiation was applied to hydrocarbons. (auth)

53013 CROSSLINKED NYLON BY IRRADIATION OF A GRAFT COPOLYMER OF NYLON WITH AN ETHYLENE/ ACRYLATE OR MODIFIED COPOLYMER. Galiano, Francis R.; Thackaberry, Samuel P.; Smith, Wayne E.; Anderson, Raymond P. (to Custom Resins, Inc.). U. S. Patent 3,681,216. 1 Aug 1972. Filed 13 Jun 1969.

The nylon articles such as films and fibers are effectively crosslinked by irradiation to obtain dimensional stability, memory, and resistance to heat and solvents without significant polymer degradation by employing a graft of a nylon polymer grown on an ethylene-acrylate copolymer as initiator and restricting the dose of ionizing radiation to a low dose of about 5 to 20 megarads. Higher doses gave a highly crosslinked polymer with significantly lower degradation than with nylon homopolymers. The preferred ethylene copolymer has a portion of the acrylate converted to amide. (Official Gazette)

53014 DECOMPOSITION OF ALDRIN BY GAMMA RADIATION. I. IN ORGANIC SOLVENTS. Carp, A. E.; Liska, B. J.; Ziemer, P. L. (Purdue Univ., Lafayette, Ind.). Bull. Environ. Contam. Toxicol.; 7: No. 6, 321-30(1972).

Aldrin, dissolved in hexane in initial concentrations of 1 mg/ml and 10 mg/ml, was irradiated at three different dosages: 0.5 Mrad, 3.0 Mrad and 6.0 Mrad. As the total absorbed dose increased, the decomposition of aldrin increased. As the percent of aldrin remaining in the sample decreased, the amounts of the products formed increased. The major radiation product has a retention time relative to aldrin of 0.72. The second most intense new peak formed by irradiation of aldrin dissolved in hexane was one with a retention time relative to aldrin of 1.20. In contrast to the 0.72 peak, the percent of the 1.20 compound was greater in the 10 mg/ml sample than it was in the 1 mg/ml sample. The effects of temperature and solvent on the radiolysis were also studied. (D.H.M.)

53015 DETERMINATION OF RATE CONSTANTS FOR THE REACTIONS OF H, OH, AND e_{aq}^- WITH INDOLE-3-ACETIC ACID AND OTHER PLANT HORMONES. Shetiya, R. S.; Rao, K. N.; Shankar, J. (Bhabha Atomic Research Centre, Bombay). Radiat. Eff.; 14: No. 3-4, 185-9(Jun 1972).

In the radiolysis of aqueous solutions of indole, indole-3-acetic acid, indole-3-propionic acid, 1-naphthylacetic acid and phenylacetic acid, the absolute rate constants of their reactions with H and OH were determined by competition kinetics using 2-propanol as the competitor. Hydrated electron reaction rate constants were determined for indole, indole-3-acetic acid and indole-3-propionic acid at pH = 11 using the decay of the hydrated electron generated by the photolysis of OH^- in a H_2 saturated solution. The rate constants were compared with literature values for other indole derivatives. (auth)

53016 EFFECT OF GAMMA RADIATION ON ION EXCHANGE RESINS. IV. DEGRADATION AND CROSSLINKING IN POLYSTYRENESULFONIC CATION EXCHANGE RESIN ZEROLIT 225 OF DIFFERENT DVB CONTENT. Narebska, Anna; Mazurkiewicz, Barbara (Univ., Torun, Poland). Nukleonika; 17: No. 3-4, 169-79(1972). (In Polish).

Investigations of the degradation and crosslinking in the polystyrenesulfonic cation exchange resin Zerolit 225 (H^+, of different DVB content), irradiated in the wet state, were performed. It was found that in samples of resin containing 1 to 2% DVB a further crosslinking occurs. The significant decrease of the ion exchange capacity and a low concentration of sulfuric acid in the eluate indicate the formation of an appreciable amount of "sulfonic bridges" in the resin. In resins containing 8, 12, and 20% DVB, crosslinking is diminished and degradation processes prevail. In irradiated Zerolit 225 at least two kinds of weakly acidic groups, differing in their radiation stability, are formed. (auth)

53017 INFLUENCE OF WATER VAPOR ON THE γ-RADIOLYSIS OF CRYSTALLINE KI. Sugier, Henryk; Tilk, Stefan (Politechniki Lodzkiej, Lodz, Poland). Nukleonika; 17: No. 3-4, 181-7(1972). (In Polish).

The radiation yield of iodine $G(I_2)$ was measured for potassium iodide crystals irradiated with ^{60}Co γ-rays within the dose range up to 1600 kI/kg (160 Mrads). The yield of iodine was calculated as a sum of gaseous iodine and iodine incorporated in the crystal. $G(I_2)$ was of the range 10^{-3} to 10^{-2} for single crystals of KI and 10^{-2} for polycrystalline samples. The yield of $G(I_2)$ is enhanced by a factor of 3 to 5 in the presence of air. It was found that the increase of $G(I_2)$ was due to the presence of water vapor which promotes a set of reactions between H_2O molecules and KI as well as between their radiolysis products. (auth)

53018 KINETICS OF THE HYDRATED ELECTRON DISAPPEARANCE IN CONCENTRATED AQUEOUS ALKALI SOLUTIONS. Kabakchi, S. A.; Shubin, V. N. (Inst. of Electrochemistry, Moscow). Radiat. Eff.; 15: No. 1-2, 23-9(Jul 1972).

Investigation of the kinetics of disappearance of optical absorption arising during pulse radiolysis of 14.5M aqueous KOH solutions revealed that the laws of disappearance of absorption at λ = 6500Å and λ = 7200Å are different. It is suggested from the spectroscopic data obtained earlier that in the region 7200Å in addition to the hydrated electron, another short-lived particle absorbs light. The modeling of chemical processes occurring in the system by means of an analogue computer allowed to determine the extinction coefficient of this particle, which is equal to 1.0×10^4 1/mol cm, and also the rate constants of the reactions of its formation and disappearance. (auth)

53019 ESR STUDY OF THE FREE RADICAL REACTIONS OF γ-IRRADIATED POLYPROPYLENE WITH METHYL METHACRYLATE. Klinshpont, E. R.; Milinchuk, V. K.; Dmitriev, S. M.; Kurilenko, A. I. (Scientific-Research Physical-Chemical Inst., Moscow). Vysokomol. Soedin., Ser. A; 14: No. 7, 1596-1602(Jul 1972). (In Russian)

The reactions of allyl, polyene, and peroxide radicals of polypropylene with methyl methacrylate were studied by the ESR method. At 300°K the relative reactivity of the radicals decreases in the sequence allyl > polyene > peroxide radicals. The kinetics of the radical reactions occurring during the gas-phase graft postpolymerization are considered. (auth)

53020 EFFECT OF VARIOUS KINDS OF IONIZING RADIATION ON POLY(VINYL CHLORIDE). Lavrentovich, Ya. I.; Zverev, A. B.; Kovalenko, L. M.; Kabakchi, A. M. (Inst. of Physical Chemistry, Kiev). Vysokomol. Soedin., Ser. B; 14: No. 5, 373-7(May 1972). (In Russian).

The effects of ^{60}Co γ radiation, 14-MeV deuterons, and 28-MeV α particles on rigid poly(vinyl chloride) (PVC) were studied with respect to polymer crosslinking and to fading of the dye 1,4-diaminoanthraquinone (DAA) in the PVC. The accumulation of a gel fraction and a change in viscosity with radiation dose began at a dose of 30 to 35 MR. The calculated radiation yield of crosslinking was about 0.9 molecule/100 eV. DAA in PVC was reduced by radiation to the leuco-form at a rate of about 0.2 molecule/100 eV, and this ratio represented a linear dependence on dose from 1 to 12 MR. (K.S.W.)

For abstracts of individual sections see: 53022–53024 and 53352.

53021 ADVANCES IN RADIATION CHEMISTRY. VOLUME 3. Burton, Milton; Magee, John L. (eds.). New York; John Wiley and Sons, Inc. (1972). 305p. $19.95.

The book is divided into four sections, each of which has been abstracted separately for NSA. (J.G.B.)

53022 SHORT-LIVED TRANSIENTS. Ludwig, Peter K. (Univ. of Notre Dame, Ind.). Advan. Radiat. Chem.; 3: 1-74 (1972).

Optical techniques for the study of fast and ultrafast processes are surveyed. Details are given on phase and modulation fluorometry, single-photon counting technique, laser flash photolysis, mode-locked laser techniques, and pulse radiolysis. Experimental results are given for the pulse radiolysis of liquid organic systems, fast pulse radiolysis of glasses, ultrafast pulse radiolysis, luminescence-decay studies, mode-locked laser studies, and laser flash photolysis. (185 references) (J.G.B.)

53023 SOME TOPICS IN RADIATION CHEMICAL SYNTHESIS OF ORGANIC COMPOUNDS. Vereshchinskii, I. V. (Inst. of Physical Chemistry, Moscow). Advan. Radiat. Chem.; 3: 75-123(1972).

The radioinduced synthesis of organic compounds is considered under the following headings: halogenation, sulfochlorination, sulfonic acid production, oxidation of hydrocarbons, hydrohalogenation, synthesis of perchlorinated hydrocarbons, telomerization, synthesis of organosilicon compounds, fluorination, carboxylation and carbonylation, synthesis of nitrogen-containing organic compounds, synthesis of sulfur organic compounds, synthesis of organophosphorus compounds, synthesis of organotin compounds, and isomerization. (176 references) (J.G.B.)

53024 RADIATION CHEMICAL MECHANISMS IN RADIATION BIOLOGY. Adams, G. E. (Mount Vernon Hospital, Northwood, Eng.). Advan. Radiat. Chem.; 3: 125-208(1972).

Radiation chemical mechanisms in radiation biology are discussed under the following headings: appropriate techniques of radiation chemistry, amino acids and peptides, enzymes and proteins, radiation chemistry of aqueous solutions of nucleic acid derivatives, and modification of cellular radiosensitivity. (212 references) (J.G.B.)

53025 CONFIGURATION DIAGRAM OF THE SOLVATED ELECTRON. Tachiya, M. (Tokyo Univ.). Chem. Phys. Lett.; 15: No. 4, 575-8(1 Sep 1972).

The absorption line shape of the solvated electron is considered in terms of the interaction of the electron with lattice vibration. Based on this consideration, the configuration diagram of the solvated electron in liquid ammonia was constructed from the absorption spectrum of it, which was obtained experimentally. The physical meaning of the constructed diagram is discussed briefly. (auth)

53026 H_3O RADICAL? Melamud, E.; Getz, D.; Schlick, S.; Silver, Brian L. (Technion–Israel Inst. of Tech., Haifa). Chem. Phys. Lett.; 15: No. 4, 590-1(1 Sep 1972).

A report of the identification of the H_3O radical is shown to be erroneous. ESR studies of aqueous solutions enriched to over 90 atom % in ^{17}O provide no evidence for the H_3O radical. The spectrum originally assigned to H_3O is probably due to the methyl radical. (auth)

53027 ABSTRACTS OF PAPERS OF THE JOINT SOUTHEAST–SOUTHWEST REGIONAL ACS MEETING, NEW ORLEANS, LOUISIANA, DECEMBER 2–4, 1970. Washington, D. C.; American Chemistry Society (1970). 220p. (CONF-701204–(Absts)).

Radiochemistry and Nuclear Chemistry

Refer also to abstracts 53027 and 53313.

53028 (COO–584–50) DISTRIBUTION OF TRITIUM IN GLUCOSE AND STARCH LABELED BY TRITIUM ATOM BOMBARDMENT. Liang, T.; Nordin, P.; Moser, H. (Kansas State Univ., Manhattan). 1972. 17p. Dep. NTIS.

Samples of glucose and starch were labeled by tritium atom bombardment. Up to 51% incorporation as non-labile tritium was achieved with crystalline, anhydrous glucose. Distribution of tritium in the carbon skeleton of glucose was calculated from a comparison of the specific molar activity of glucose with its derivatives. Derivatives prepared were gluconic acid, glucose phenyl osatriazole, 2-phenyl-4-formyl osatriazole, 2-phenyl-4-carboxylic acid osatriazole, glucose phenyl flavazole, 1-phenyl-3-formyl flavazole and formaldehyde dimedone. The tritium distribution showed definite structural effects. Generally films of glucose and the amylose–butanol complex had random or nearly random distribution of tritium in glucose. Crystalline α-D-glucose monohydrate had zero tritium on C-2 and twice random tritium on C-5. Starch granules had zero or near zero tritium on C-3 and close to twice random tritium on C-2. (auth)

53029 LABELED IODOQUINE. Moretti, Jean-Luc; Safi, Nour. French Patent 2,081,592. 10 Dec 1971. Filed 27 Mar 1970. (In French).

A method was developed for preparing and labeling 7-iodo(131) and 7-iodo(125)-4(4-diethylamino-1-methylbutylamino)quinoline. The 7-chloroquine is treated using a radioactive iodizing reagent in order to substitute the chlorine atom with a labeled iodine atom. The labeled iodizing reagent consists of KI, sodium nitrite, HCl and a molecular iodine isotope: ^{125}I, ^{131}I or ^{134}I. (France)

Hot-Atom Chemistry

Refer also to abstract 52962.

53030 EFFECT OF SCAVENGER COMPETITION ON HOT ATOM CHEMISTRY. II. COMPUTER SIMULATION. Malcolme-Lawes, D. J. (Yale Univ., New Haven). J. Chem. Phys.; 57: No. 6, 2481-7(15 Sep 1972).

A computer model is used to simulate the effect of varying amounts of scavenger competition in a hot atom system consisting of reactant, inert moderator, and scavenger. The results were analyzed in terms of the kinetic theory of hot atom reactions. The scavenger corrected kinetic theory was tested and shown to yield adequately corrected kinetic parameters. (auth)

53031 EFFECT OF SCAVENGER COMPETITION ON HOT ATOM CHEMISTRY. I. CORRECTION TO THE KINETIC THEORY. Malcolme-Lawes, D. J. (Yale Univ., New Haven). Contract AT(30-1)-1957. J. Chem. Phys.; 57: No. 6, 2476-80 (15 Sep 1972).

The effect of scavenger reactivity in a hot reaction zone is considered using the model and symbolism of the kinetic theory of hot atom reactions. Expressions were derived, which enable the extent of scavenger interference to be estimated from experimental scavenger curves, and a simple method of correcting available kinetic theory parameters is given. (auth)

53032 LIFETIME VARIATION OF ^{64}Cu AND THE CHEMICAL STATE OF (n,γ) RECOIL COPPER IN α-COPPER PHTHALOCYANINE CRYSTALS. Auric, P.; Vargas, J. I. (CEN, Grenoble, France). Chem. Phys. Lett.; 15: No. 3, 366-8(15 Aug 1972).

The decay constant, λ, of ^{64}Cu in α copper phtalocyanine is changed by $\Delta\lambda/\lambda = (10 \pm 1.6) \times 10^{-4}$ when the electron capture decay rate in the labeled crystal is compared to that of samples in which the ^{64}Cu activity was introduced by neutron irradiation. It is shown that the (n,γ) generated recoil copper is probably lattice stabilized in the atomic state. (auth)

Properties of Radioactive Materials

Refer also to abstracts 52934, 52935, 52955, and 53548.

53033 (EUR–4765, pp 117-30) SURFACE IONIZATION APPLIED TO SOME MATERIALS OF NUCLEAR INTEREST. Facchetti, S.; Marell, A. (CCR-Euratom, Ispra, Italy). (In Italian).

From 2nd conference on mass spectrometry; Ispra, Italy (1 Sep 1971).

In working with sources of surface ionization it is difficult to obtain reproducible conditions because of the multiplicity of parameters, but the effort to do so may be justified by the results. The difficulties are discussed, and related to the ideal case of a polished surface in the absence of external electric fields when the Langmuir–Saha expression applies. The Schottky equation correlates the desorption of a given ion from a surface, and pertinent data are tabulated for the elements U and Th. Other elements referred to in connection with the surface ionization techniques are Nd, Pu, W, and Np. (K.S.W.)

53034 (MLM–1964(tr)) HYDROLYSIS OF TETRAVALENT PLUTONIUM. Mativier, H.; Guillaumont, R. Translated for Mound Lab., Miamisburg, Ohio, from Radiochem. Radioanal. Lett.; 10: No. 2, 27-35(1972). 9p. Dep. NTIS.

Hydrolysis constants for Pu^{4+} were calculated by solvent extraction of Pu(IV) in the system $HClO_4$–$LiClO_4$–TTA or dibenzoylmethane–benzene with ^{238}Pu. Analysis of distribution coefficient using a computer gave: $\log K_1 = -0.45$, $\log K_2 = -0.75$, $\log K_3 = -3.3$, $\log K_4 = -6.3$. Conditions were found for stability of tetravalent plutonium in this system and the extraction of plutonium(IV) by isopropyltropolone in benzene. (See NSA 26: 30884 for abstract from original language.) (auth)

53035 (NIM–1448) POTENTIOSTATIC STUDY OF THE ANODIC DISSOLUTION OF URANIUM DIOXIDE IN AQUEOUS SOLUTIONS. Nicol, M. J.; Needes, C. R. S. (National Inst. for Metallurgy, Johannesburg (South Africa)). 8 Jun 1972. 23p. Dep. NTIS (U. S. Sales Only).

The anodic dissolution of uranium dioxide is shown to occur as a two-electron process with a current efficiency of 100% in both acidic perchlorate and alkaline carbonate solutions. The effects, on the anodic dissolution process, of pH, temperature, and the various anions known to be present in commercial leaching solutions, were studied by the use of stationary potentiostatic measurements. The effects observed are interpreted in terms of the nature and properties of both the uranium dioxide surface and the primary products of oxidation. (auth)

53036 (ORNL–4794, pp 81-3) SPECTROPHOTOMETRIC STUDIES OF SOLUTIONS OF LANTHANIDES AND ACTINIDES. Aug 1972.

In Chemical Technology Division annual progress report for period ending March 31, 1972.

Research progress is reported on: studies of plutonium(IV) polymer, spectral studies of the actinides, and protonic wave functions and spectra. (D.H.M.)

53037 (RFP–1455) TEMPERATURE MEASUREMENT AND CONTROL IN THE BOMB REDUCTION OF PLUTONIUM TETRAFLUORIDE. Long, Jack L.; Brown, James C.; Auge, Robert G. (Dow Chemical Co., Denver, Colo. Rocky Flats Div.). 11 Sep 1972. Contract AT(29-1)-1106. 7p. Dep. NTIS.

A technique was developed for estimating the minimum temperatures attained in small and large scale bomb reductions of plutonium tetrafluoride with calcium metal. The temperatures in both the small (50 gram) scale and large (1.8 kg) scale exceeded 1900°C. The addition of calcium fluoride slag from previous reductions lowered the temperature to less than 1536°C. Slag addition to 2.5 kg reductions resulted in practically no splattering of the molten reaction products and in increased reduction yields. (auth)

53038 (RFP–1889) CONVERSION OF PLUTONIUM OXIDE TO PLUTONIUM TETRAFLUORIDE WITH FLUORINE IN A FLUID BED REACTOR. PART I. DEVELOPMENT STUDIES. Standifer, Richard L.; Robinson, Herbert N.; Sheets, James R.; Wing, Ralph O. (Dow Chemical Co., Denver, Colo. Rocky Flats Div.). 23 Aug 1972. Contract AT(29-1)-1106. 11p. Dep. NTIS.

The use of gaseous fluorine (F_2) to convert purified plutonium oxide (PuO_2) to plutonium tetrafluoride (PuF_4) in a fluidized bed reactor was investigated for possible process application. Through a series of 500-gram to 1000-gram batch fluid bed runs, a set of conditions and techniques was determined, which yielded PuF_4

suitable for the requirements of the Rocky Flats plutonium recovery process. The conversion of PuO_2 to PuF_4 in the recovery process is currently accomplished with anhydrous hydrogen fluoride (HF), using a rotary tube reactor. Extensive tests are planned to fully evaluate the fluid bed-fluorine process as a potential replacement for the current hydrofluorination process. (auth)

53039 (RFP-1890) CONVERSION OF PLUTONIUM OXIDE TO PLUTONIUM TETRAFLUORIDE WITH FLUORINE IN A FLUID BED REACTOR. PART II. DEMONSTRATIONS RUNS: A COMPARISON OF THE FLUORINE PROCESS WITH THE HYDROFLUORINATION PROCESS. Standifer, Richard L.; Wing, Ralph O.; Sheets, James R.; Robinson, Herbert N.; Meyer, F. Graham; Wolf, Jerry R.; Ramsey, William H. (Dow Chemical Co., Denver, Colo. Rocky Flats Div.). 29 Aug 1972. Contract AT(29-1)-1106. 21p. Dep. NTIS.

A series of 82 1-kg-batch pilot plant runs was made to demonstrate the potential of a process using fluorine and a fluid-bed reactor to convert plutonium oxide (PuO_2) to plutonium tetrafluoride (PuF_4). A comparison of this process with the rotary hydrofluorination process, currently used to generate PuF_4 in the Rocky Flats plutonium recovery plant, indicated that replacement of the existing process would result in a number of significant improvements. Properly designed, a fluid bed-fluorine system should reduce the radiation exposure rate presently experienced by the hydrofluorination process operators by a factor of 10. This reduction in exposure would result from the smaller inventory of PuF_4 and the relative ease of remote operation of the fluid bed-fluorine process. Use of the fluorine process would eliminate the generation of approximately 10,000 gallons/month caustic waste solution containing an average of approximately 170 grams plutonium. This waste stream, with the contained plutonium, must be processed for water removal, and ultimately, shipped off-site for burial. The fluorine process should reduce the quantity of plutonium recycled by: reducing the quantity of impure PuF_4 and improving the yield of plutonium metal in the calcium reduction operation. Approximately 95% of the recycle from these sources should be eliminated. Based on an average recovery rate of 400-kg plutonium metal per month and a recycle processing cost of $1,000-per-kilogram plutonium recycled, cost calculations show a potential savings of approximately $1.25 million/year by replacing the present hydrofluorinators with a fluid bed-fluorine system. The demonstration runs indicate that because of reduced corrosion and the use of multiple small reactors, dependability and maintenance requirements appear more favorable with the fluid-bed fluorine process. No significant disadvantages were apparent during this series of demonstration runs. (auth)

53040 (SZS-129) APPLICATION OF ORGANIC FLOCCULANTS TO THE DECONTAMINATION OF RADIOACTIVELY CONTAMINATED WATERS BY COAGULATION. Vostrcil, J. (Staatliche Zentrale fuer Strahlenschutz, Berlin (East Germany)). Apr 1972. 60p. (In German). Dep. NTIS (U. S. Sales Only).

The effect of organic flocculants on water decontamination both by ferric chloride coagulation and by a two-stage lime-soda softening with subsequent ferric chloride coagulation. The use of optimum amounts of organic flocculants for improving the removal of turbidity, better sedimentation, and separation of flocs formed during coagulation was investigated. The effect of organic flocculants was studied both by means of jar tests and with a model of floc blanket clarifier. Optimum amounts of organic flocculants for given processes reduce primarily final turbidity of the treated water and by this method improves the removal of those radionuclides that are present in water in colloidal form or that were incorporated into the formed flocs. The amounts of organic flocculants must be optimum because an excess of organic flocculants may impair the process of decontamination. In removing ^{144}Ce and ^{106}Ru from water by ferric chloride coagulation a similar relationship was found between the modified CAMP number and decontamination factor and/or decontamination efficiency as between CAMP number and residual iron and/or final turbidity in the treated water. (auth)

53041 (UJV-2867-M,A) ABSOLUTE ACTIVITY IN IRRADIATED FUEL MATERIAL BY THE METHOD OF "GAMMA SCANNING". Klima, Jaroslav; Kyncl, Jan; Macku, Ales; Vins, Vaclav; Pour, Frantisek; Havel, Jaroslav (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). Dec 1971. 21p. (In Czech). Dep. NTIS (U. S. Sales Only).

A self-absorption correction for gamma scanning of UO_2 pellets is described. The linear absorption coefficient for gamma radiation was measured for the energy of 0.662 MeV (Cs) in pellets of sintered UO_2 in the range of 74 to 96% of the theoretical density of the pellets. The gamma scanning system in hot cells at the Nuclear Research Institute in Řež is described. (auth)

53042 BENZOATO COMPLEXES OF URANYL. III. INFRARED SPECTRUM AND STRUCTURE OF DIOXOBISBENZOATODIAQUOURANYL(VI), $[UO_2(C_6H_5COO)_2(H_2O)_2]$. Rojas Lopez, R. M.; Arenas Rosado, J.; Bermudez Polonio, J. (Instituto de Quimica Inorganica, Madrid). An. Quim.; 68: 223-8(1972). (In Spanish).

The infrared spectra of the compounds $[UO_2(C_6H_5COO)_2(H_2O)_2]$ and $[UO_2(C_6H_5COO)_2]$ were studied in the spectral region of 4000 to 200 cm^{-1}. The previously proposed structure of the uranyl benzoate was confirmed and on the basis of the spectral data, a structure with hexacoordinated UO_2^{++} is proposed for the former compound. (auth)

53043 FLUORO COMPLEXES OF HEXAVALENT URANIUM. IV. COMPLEXES OF THE SERIES $[UO_2F_3]^-$ AND $[(UO_2)_2F_5]^-$. Chakravorti, M. C.; Bandyopadhyay, N. (Indian Inst. of Tech., Kharagpur). J. Inorg. Nucl. Chem.; 34: No. 9, 2867-74(Sep 1972).

Thermogravimetric studies were made of various salts of the ion $[UO_2F_3]^-$ with organic basic cations. By the pyrolysis of the complexes of the salts with α-picoline, quinoline, 2,2'-dipyridyl (indexed as bipyridine), and anthranilic acid, compounds of the type $BH[(UO_2)_2F_5]$ were isolated. Similar salts with dimethylaniline, cis- and trans- $[CO(NH_3)_4F_2]^+$ and also the quinoline compound were obtained by direct precipitation of uranyl fluoride with the organic bases or with salts containing the complex cations in dilute HF medium. The conductivities and the solubilities of the salts and also of the salts belonging to the series $[UO_2F_3]^-$ were determined. A free acid formulated as $H[UO_2F_3] \cdot H_2O$ was isolated by reacting uranium trioxide with aqueous HF. It was characterized by conductivity and pH measurement of dilute solutions, potentiometric titration with alkali, determination of dissociation constant, thermogravimetric analysis, and by a comparison of these results with those of $UO_2F_2 \cdot 2H_2O$. (auth)

53044 MECHANISMS OF INORGANIC REACTIONS. PART I. THE KINETICS AND MECHANISM OF THE OXIDATION-REDUCTION REACTION OF URANIUM(IV)-CHLORINE(III) IN THE PRESENCE OF EXCESS PHENOL IN AQUEOUS ACID SOLUTION. PART II. THE TRANS EFFECT IN THE SUBSTITUTION REACTIONS OF IODOAQUOTETRAAMMINECHROMIUM(III). Buchacek, Robert Joseph. Iowa City, Iowa; Univ. of Iowa (1972). 105p. University Microfilms Order No. 72-17,543.

Thesis.

The oxidation-reduction reaction of uranium(IV)-chlorine(III) was studied in the presence of 0.1 M phenol. The addition of phenol to the reaction mixture effectively removes the side reactions of the intermediate Cl_2O_2 product. Under these conditions the stoichiometry of the reaction is represented by U(IV) + Cl(III) + phenol $\rightarrow$ U(VI) + H^+ + chlorophenols. The results of an oxygen-18 tracer analysis suggest that the principal pathway involves a two-electron oxygen atom transfer from chlorine(III) to uranium(IV). An increase in the concentrations of both chlorine(III) and hydrogen ion retard the rate of the reaction. (Diss. Abstr. Int., B)

53045 CRYSTALLOGRAPHIC STUDY OF TETRAVALENT M(IV)$(PO_3)_4$ COMPOUNDS (M(IV) = Ce, U, AND Th). Masse, Rene; Grenier, Jean-Claude (CNRS, Grenoble, France). Bull. Soc. Fr. Miner. Crist.; 95: No. 1, 136-42(Jan 1972). (In French).

The chemical preparation of orthorhombic $Ce(PO_3)_4$ crystals, orthorhombic and triclinic $U(PO_3)_4$ crystals, and orthorhombic, triclinic, and quadratic $Th(PO_3)_4$ crystals is described. The Weissenberg method was used to determine the crystallographic parameters of the various lattices. The powder diagrams of these phosphates are presented. (France)

53046 LATTICE DYNAMICS OF M_2XY_6 HEXABROMOMETALLATES: Cs_2UBr_6. Chodos, Steven L. (Univ. of California, Los Angeles). J. Chem. Phys.; 57: No. 7, 2712-14(1 Oct 1972).

A seven parameter model based on a modified Urey-Bradley potential with long range Coulomb terms was used to describe the lattice dynamics of M_2XY_6 compounds. Optical data were used to evaluate the force constants for the case of Cs_2UBr_6. The model is to be used as a starting point for a comprehensive calculation of the vibronic structure of Cs_2UBr_6. (auth)

53047 STABLE URANIUM(IV) ALKYL AND ARYL COMPLEXES. Marks, Tobin J.; Seyam, Afif M. (Northwestern Univ., Evanston, Ill.). J. Amer. Chem. Soc.; 94: No. 18, 6545-6(6 Sep 1972).

The synthesis of a series of compounds $(h^5-C_5H_5)_3$ UR (where R = CH_3, n-C_4H_9, allyl, neopentyl, C_6F_5, and i-C_3H_7) is reported. NMR data are presented for the compounds. The molecules all possess considerable thermal stability. All compounds reacted instantly with methanol producing as the major product $(C_5H_5)_3$ $UOCH_3$. No reaction was observed when it was attempted to

bring about nucleophilic addition of $(C_6H_5)_3UCH_3$ to acetone. (D.H.M.)

53048 LIQUID AND SOLID Th–OH–NO_3–H_2O SYSTEMS. INFRARED AND LIGHT SCATTERING INVESTIGATIONS. Deptula, Andrzej (Inst. of Nuclear Research, Warsaw). Nukleonika; 17: No. 1-2, 47-58(1972).

Infrared investigations indicate that in solutions of Th–OH–NO_3–H_2O systems a weak interaction of the type Th^{4+}–$(H_2O)_x$–NO_3^- takes place (independent of the NO_3 : Th molar ratio). In the following solid compounds of this system $Th(NO_3)_4 \cdot 4H_2O$ (I), $Th_2(OH)_2(NO_3)_6(H_2O)_8$ (II), $Th(OH)_2(NO_3)_2(H_2O)_3$ (III), and in thoria gels the nitrates are coordinated as a bidentate nitrate groups (Th ⩵ O_2NO). In compounds (I) and (II), the strength of every coordination bond Th ⁓ O–N is different, but in (III) as well as in thoria gels the Th ⁓ O–N bonds are of equal strength. The outer oxygen atoms of the nitrate groups are engaged in different hydrogen bonds. On the basis of light scattering measurements it was found that thoria sols are formed in solutions of molar ratios NO_3 : Th < 2 : 1. The smaller the NO_3 : Th molar ratio and older the sols the bigger the molecular weight of the sol and larger the grain size of the corresponding gel. Dissymmetry values and depolarization factors of the scattered light indicate that particles of the investigated thoria sols are spherical and isotropic. (auth)

53049 PROCESS FOR PREPARING ALPHA AMMONIUM URANOUS PENTAFLUORIDE. Selman, Murray; Wamser, Christian A.; Wilkalis, John E. (to Allied Chemical Corp.). U. S. Patent 3,681,035. 1 Aug 1972. Filed 1 Oct 1969.

NH_4UF_5 was prepared in alpha crystalline form by adding to an aqueous acidic solution of a uranyl salt containing cupric ions, chloride ions and ammonium ions, hydrogen fluoride and hydroxylamine. The hydroxylamine was added in amounts and time of addition so as to maintain a concentration of at least about 0.07 mol of hydroxylamine per liter of solution until the major portion of the uranium in the uranyl salt was converted to NH_4UF_5. (Official Gazette)

53050 PREPARATION OF AQUEOUS SOLUTIONS OF THORIA SOLS FOR LIGHT SCATTERING MEASUREMENTS. Deptula, Andrzej (Inst. of Nuclear Research, Warsaw). Nukleonika; 17: No. 3-4, 197-8(1972).

It was shown that deionized water can be used to prepare solutions for light scattering measurements. The procedure is as follows: 1) preparation of concentrated solutions using deionized water (e.g., 2.15 M thoria sol with molar ratio NO_3 : Th = 0.5 : 1); 2) filtration of this solution through G-5 Jena sintered glass under pressure (~0.5 atm) of nitrogen; 3) preparation of basic solutions by dilution of the concentrated solutions with deionized water (e.g., 2.23 cm^3 of thoria sol was diluted to 100 cm^3 in order to obtain a concentration of 0.011 g/cm^3); and 4) preparation of solutions of various concentrations for light scattering measurements directly in the cell, e.g., to 40 cm^3 of deionized water contained in the cell different volumes from 0.03 to 1.8 cm^3 of the basic solution (see point 3) were added. The observed dissymmetry in the concentration range 0.834 to 47.929×10^{-5} gTh/cm^3 varied from 0.8 to 1.23. The molecular weight was found to be 2,540,000. (auth)

53051 KINETICS AND MECHANISM OF THE OXIDATION–REDUCTION REACTION BETWEEN URANIUM(IV) AND CHLORINE(III) IN THE PRESENCE OF PHENOL IN AQUEOUS ACID SOLUTION. Buchacek, Robert; Gordon, Gilbert (Univ. of Iowa, Iowa City). Inorg. Chem.; 11: No. 9, 2154-60(Sep 1972).

The oxidation–reduction reaction between uranium(IV) and chlorine(III) was studied in the presence of 0.1 M phenol. The addition of phenol to the reaction mixture effectively removes the side reactions of the chlorine-containing intermediates. Under these conditions the stoichiometry of the reaction becomes U(IV) + Cl(III) + phenol ⁓ U(VI) + H^+ + chlorophenols. The results of an ^{18}O tracer experiment suggest that the principal pathway involves a two-electron oxygen atom transfer from the oxidant to the reductant. An increase in the concentrations of both chlorine (III) and hydrogen ion retards the rate of the reaction. The data are consistent with the rate expression $-d[U(IV)]/dt = k_1[U(IV)][Cl(III)]/\{1 + K_2[HClO_2]\}\{1 + K_3[H^+]\}$. At 25°C, $k_1 = 291.3 \pm 4.2$ M^{-1} sec^{-1}, $K_2 = 4.13 \pm 0.25$ M^{-1}, and $K_3 = 20.8 \pm 3.2$ M^{-1}. Mechanistically, the rate law is interpreted in terms of a hydrogen ion dependent two-electron transfer reaction and the formation of a nonproductive intermediate. (auth)

53052 SYNTHESIS OF NEW COMPOUNDS LABELED WITH TRITIUM AND ^{14}C FOR BIOLOGICAL INVESTIGATIONS. I. COMPOUND ROM-203:N,N'-BIS(3-PHENOXYHYDROXYPROPYL)-ETHYLENEDIAMINE,2HCl. Ozdowska, Zofia; Marjankowska, Barbara (Instytut Farmaceutyczny, Warsaw). Nukleonika; 17: No. 3-4, 163-8(1972). (In Polish).

In a deuteration reaction the positions of protons that undergo to isotope exchange with deuterated and tritiated water were designed. The compound ROM-203 was labeled with tritium and carbon-14. (auth)

53053 APPLICATION OF THE MENDELEEV PERIODIC LAW TO ELEMENTS HAVING Z VALUES LYING BETWEEN 104 AND 107. Haissinsky, M. (Institut du Radium, Paris). J. Chim. Phys.; 69: No. 5, 845-50(May 1972). (In French).

It is assumed that the close analogies that exist between the following couples: Zr and Hf, Nb and Ta, Mo and W, and Tc and Re (32 electron difference) should also exist for the following couples: Hf–104, Ta–105, W–106, Re–107 (32 electron difference). This hypothesis enables approximate values to be obtained by extrapolation for the ionic and atomic radii, the ionization potential, and the electronegativities of the four elements immediately preceding the filling-up of the 5f shell. Using these values together with data concerning the physico-chemical behavior of the homologues, it is demonstrated that the essential chemical features of the four elements can be predicted. (France)

53054 FORMATION OF COMPLEXES OF UCl_4 WITH α- OR β-CARBOXYLIC ACIDS AND α-QUINOLINECARBOXYLIC ACID IN POLAR SOLUTIONS. Rakhimov, Kh. R.; Khamraev, T. A.; Muftakhov, A. G. (Tashkent State Univ.). Uzb. Khim. Zh.; No. 2, 29-32(1972). (In Russian).

Complex formation of UCl_4 with representative monopyridine carboxylic acids (picolinic and nicotinic acids) and α-quinolinecarboxylic acid was studied in water and alcohol solutions by means of a spectrophotometer. Compounds with the following compositions were detected: 1 : 1 and 1 : 2 (U^{+4} : α-picolinic acid) in water or C_2H_5OH, but only 1 : 1 in CH_3OH; 1 : 1 and 1 : 2 (U^{+4} : β-nicotinic acid) in C_2H_5OH; and 1 : 2 (U^{+4} : α-quinolinecarboxylic acid) in C_2H_5OH. (K.S.W.)

53055 COMPUTER ANALYSIS OF SPECTRA BY DECONVOLUTION. Szoke, J. (Central Research Inst. for Physics, Budapest). Chem. Phys. Lett.; 15: No. 3, 404-7(15 Aug 1972).

An iterative deconvolution procedure was applied in order to eliminate instrument distortions from a spectrum and to determine the number and the approximate parameters of spectrum components that can be used as input parameters for a least squares fit procedure. The spectrum of ammonium uranyl carbonate is used as one example. (auth)

Radioactive Waste Treatment

Refer also to abstract 52915.

53056 (AREAEE–129) RADIOCHEMICAL STUDIES OF ^{125}I, PART I. PRODUCTION AND SEPARATION. Allam, S. (Atomic Energy Establishment, Cairo (Egypt). Nuclear Chemistry Dept.). 1971. 32p. Dep. NTIS (U. S. Sales Only).

The preparation and purification of the ^{125}I are reported. The production of the isotope was achieved by using 83% enriched ^{125}Te as a target material. Irradiation experiments were carried out at the 60 inch cyclotron of the Argonne National Laboratories. The isotope was separated by distillation, and chemically purified from the target material, which was recovered for further irradiations. The specific activity yield obtained was 4.65 mCi/g for a proton flux of 1 W/h and no traces of contaminating ^{126}I were detected three weeks after irradiation. Different counting techniques were investigated and the results indicated that 50% efficiency was achieved by gamma scintillation well-type detectors, and 15% efficiency by liquid scintillation methods. Activity levels of ^{125}I as small as 1×10^{-3} microcurie may be determined with an absolute accuracy of ±1%. (auth)

53057 (BNWL-tr-75) MELTING OF RADIOACTIVE SUBSTANCES IN GLASS OR CERAMIC SUBSTANCES. THIRD COMMUNICATION: SUITABILITY STUDY OF VULCANITES OF DOMESTIC ORIGIN. Sachse, G.; Rosenberger, H. Translated for Battelle Pacific Northwest Labs., Richland, Wash., from Kernenergie; 11: No. 1, 15-23(1968). 20p. Dep. NTIS.

The characteristics of basalts, phonolites, trap tuff, and pitchstones for use in radioactive waste disposal are evaluated. Results show that Barenstein basalt, Kaltenstein phonolite, and Hammer–Unterwiesenthal phonolite are considered good to excellent. (D.H.M.)

53058 (CONF-720823–10) LONG-TERM EFFECTS ON RADIOIODINE TRAPPING BY CHARCOAL. Davis, R. J.; Ackley, R. D. (Oak Ridge National Lab., Tenn.). 1972. 15p. Dep. NTIS.

From twelfth air cleaning conference; Oak Ridge, TN. (28 Aug 1972).

A program of tests is underway to determine the $CH_3{}^{131}I$ efficiencies of some commercial impregnated charcoals as a function of time exposed to reactor off-gas. A TEDA-impregnated charcoal retained a high $CH_3{}^{131}I$ trapping efficiency (>90%) during six months

service whereas an iodized charcoal retained that efficiency for only about one month. The $CH_3{}^{131}I$ trapping efficiency test was performed at 90% relative humidity with a loading of about 0.4 mg I as CH_3I/cm^3 of bed. This test loading is about ten times larger than the maximum total iodine loading estimated to be possible in ORNL off-gas systems and additional tests are underway to determine whether the trapping efficiencies for a more realistic loading will be maintained for a longer service period. A second, more urgent problem is related to the slow release of iodine from charcoal beds. The ORNL need is to provide a method of predicting, from a short-term, in-place test result, the fraction of iodine that would be retained over a period of several weeks under accident and post-accident conditions. The results of some long-term (28 day) iodine retention tests are presented and compared with previous results (from ORNL and elsewhere). The releases are larger than acceptable under some conditions. The release depends on at least four environmental parameters: the prevailing relative humidity, the service history, organic contamination in the air, and ionizing radiation. Additional tests are in progress to demonstrate the magnitude of the first three of these parameters. It is anticipated that the results of the planned tests, along with those from the Savannah River Laboratory program pertaining to the effects of radiation, will provide an outline of the magnitude of possible iodine releases from adsorbers under ORNL usage. (auth)

53059 (CONF-720823-12) DECONTAMINATION OF HTGR REPROCESSING OFF-GASES. Whatley, M. E.; Glass, R. W.; Haas, P. A.; Meservey, A. B.; Notz, K. J. (Oak Ridge National Lab., Tenn.). 1972. 22p. Dep. NTIS.

From twelfth air cleaning conference; Oak Ridge, TN. (28 Aug 1972).

Off-gas from the reprocessing of HTGR fuel elements contains large amounts of CO_2 produced by the burning of fuel elements that contain about ten times as much graphite as heavy metals. The relatively high temperature of the burning process (~800°C) releases virtually all of the volatile fission products, and troublesome amounts of some that are normally solid. Filters remove particulate solids and sorption methods are used for I_2 and ^3H_2O, but no existing technology was found to remove and concentrate the Kr. The high concentration of CO_2 in the filtered gas stream (~90%) CO_2, 10% light gases, 10 to 20 ppM Kr), and the similarity of CO_2 behavior to that of Kr preclude the use of commonly employed processes such as membrane permeation, sorption on charcoal or molecular sieves, and physical absorption by a third component. The removal of CO_2 before such an operation appears feasible, but undesirable. A process involving Kr absorption in liquid CO_2 (KALC), which exploits the fact that Kr is more soluble in liquid CO_2 than is O_2, N_2, or CO, appears to be a natural solution to this particular problem. The solubility of Kr in liquid CO_2 was experimentally determined by an in situ radioactive counting method using ^{85}Kr. Kr (a total content of about 100 ppM) and CO_2 were contained in a sealed stainless steel tube, brought to equilibrium by rocking in a constant temperature bath, and counted with the tube in a vertical position to measure the radioactivity in each phase. Data were obtained at various temperatures over almost the entire CO_2 liquid range. Engineering calculations, based on literature values for the solubility of O_2, N_2, and CO and the measured values for Kr, on a KALC system that employs a fractionator and a stripper as well as an absorber indicate that a decontamination factor for Kr of 1000 can be achieved and that the Kr can be concentrated such that it comprises several percent of the removal stream. The Rare Gas Removal Pilot Plant at the ORGDP was used to explore the feasibility of operating a KALC system. In addition to demonstrating that feasibility, the initial pilot campaign provided encouragement that the KALC process will be a good way to decontaminate the HTGR reprocessing off-gases. (auth)

53060 (CONF-720823-14) ESTIMATE OF THE PROCESS DECONTAMINATION FACTORS REQUIRED TO MEET FEDERAL EFFLUENT REGULATIONS FOR THE BURNING OF HTGR FUEL ELEMENTS. Snider, J. W.; Leuze, R. E. (Oak Ridge National Lab., Tenn.). 1972. 26p. Dep. NTIS.

From 12th air cleaning conference; Oak Ridge, TN. (28 Aug 1972).

Calculations were made of the various quantities of air required to dilute 139 isotopes, present at two reprocessing times, in HTGR fuel elements to meet existing federal effluent regulations. One isotope (^{238}Pu) represents 79% of the total, calculated isotopic potential hazard from the burning of HTGR fuel elements. The largest calculated decontamination factor required was 640,000 for ^{238}Pu. (auth)

53061 (DP-MS-72-14) EFFECT OF INTENSE GAMMA RADIATION ON RADIOIODINE RETENTION BY ACTIVATED CARBON. Evans, A. G. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). 1972. Contract AT(07-2)-1. 14p. (CONF-720823-8). Dep. NTIS.

From 12th air cleaning conference; Oak Ridge, TN. (28 Aug 1972).

Most nuclear reactor installations have activated carbon beds to confine radioactive halogens following a reactor accident. The intense radiation field resulting from adsorption of radiohalogens on these carbon beds can convert elemental halides to organic halides. The rates of formation and desorption of organic iodides are functions of radiation field intensity, relative humidity of the purge gas stream, type and service history of the carbon, and particle size distribution of the carbon. The principal formation mechanisms are probably free radical reactions; the necessary reaction components for these reactions are water, iodine, carbon, and an intense radiation field. Desorption rates from several types of carbon and inorganic-base iodine adsorbers under various conditions are presented. Impregnated adsorbers (carbon and inorganic) retain iodine better under gamma radiation than unimpregnated carbons. New triethylenediamine-impregnated carbons have the best overall retention characteristics of the materials tested to date. Service aging characteristics are being determined. The type of carbon and method of impregnation may significantly affect iodine retention, particularly at higher temperatures (up to 180°C). (auth)

53062 (LA-DC-72-920) SIZE CHARACTERISTICS OF PLUTONIUM AEROSOLS. Ettinger, Harry J.; Elder, John C.; Gonzales, Manuel (Los Alamos Scientific Lab., N. Mex.). [nd]. 15p. (CONF-720823-13). Dep. NTIS.

From 12th air cleaning conference; Oak Ridge, TN. (28 Aug 1972).

A program is in progress to measure size characteristics and activity concentrations (source term) of plutonium aerosols generated by typical operations handling significant quantities of plutonium. This will provide a basis for generating similar aerosols in the laboratory to study the effectiveness of multiple stages of HEPA filtration. Initial data shows Pu concentrations ranging up to 16.5×10^6 dpm/m^3, with the following aerodynamic size characteristics: aerodynamic activity median diameter (aamd) = .52 to 5.5 μm and geometric standard deviation (σ_g) = 1.5 to 6.60. (auth)

53063 (ORNL-4794, pp 33-5) WASTE TREATMENT AND DISPOSAL. Aug 1972.

In Chemical Technology Division annual progress report for period ending March 31, 1972.

Research progress is reported on: radioactive waste repository, thermal stability of alpha wastes, isotope migration in crushed salt, engineering economic and safety evaluations, and combustion of plutonium-bearing solid wastes. (D.H.M.)

53064 (ORNL-tr-2621) SEPARATION OF FISSION PRODUCT RARE GASES FROM COMBUSTION WASTE GASES FROM HIGH TEMPERATURE FUEL ELEMENTS BY SCRUBBING WITH LIQUID CARBON DIOXIDE. Laser, M.; Beaujean, H. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Chemische Technologie). Translated by R. Gregg Mansfield (Oak Ridge National Lab., Tenn.), from German report. 14p. (CONF-710966-1). Dep. NTIS.

From Meeting of the Society of German Chemists; Karlsruhe, Germany (13 Sep 1971).

The solubility of krypton in liquid CO_2 was studied, and the data used for developing a process for the absorption of rare gas fission products from combustion off-gases. The off-gas is compressed, passed through a heat exchanger into a packed column where it is scrubbed countercurrently with liquid CO_2. The decontaminated gas can be discharged through a reducing valve, and the liquid CO_2 containing Kr fractionated. The purified CO_2 is withdrawn from the sump of the fractionating column and returned to the head of the absorber column. The design of the installation is given by means of McCabe-Thiele diagrams. (J.G.B.)

53065 ESTIMATION OF THE COST OF PROCESSING LIQUID RADIOACTIVE WASTES. Pavlov-Verevkin, B. S.; Krasnaya, M. F. At. Energ. (USSR); 32: No. 6, 463-4(Jun 1972). (In Russian).

On the basis of data from several waste-water deactivation stations, the dependence of the cost of processing on station capacity and level of deactivation technology is determined. It is shown that the logarithm of the required cost of processing is linearly dependent on the logarithm of the station capacity. Depending on the level of technology there will be corresponding deviations from this theoretical cost. The obtained relationship is suitable for preliminary estimation of the cost of processing for a given station capacity and makes it possible to compare the economic efficiencies of water-purifying stations of various capacities. (auth)

Radioisotope Production

Refer also to abstract 53337.

53066 (ORNL-4794, pp 36-44) TRANSURANIUM-ELEMENT PROCESSING. Aug 1972.

In Chemical Technology Division annual progress report for period ending March 31, 1972.

ACTINIDE HYDRIDES — preparation and characterization of, p.41
ACTINIDE HYDROXIDES — crystal structure of, electron microscopic, electron diffraction, and x-ray diffraction studies of, p.42-3
ACTINIDE OXIDES — crystal structure of, electron diffraction study of, p.42
ACTINIDES — complexes of trivalent, research on sulfate and thiocyanate, pp.39-41
— preparation by vapor deposition, p.42
AMERICIUM HALIDES — preparation of divalent, p.42
CALIFORNIUM-252 — calibration of neutron source of, with fast neutron detector, p.38
— fabrication of neutron sources of, p.38
CURIUM-244 — preparation of high purity, by reduction of curium oxide, p.41
GAMMA SOURCES — preparation for Moessbauer studies, pp.38-9
LANTHANUM HYDRIDES — preparation and characterization of, p.41
TRANSURANIUM ELEMENTS — phase diagrams of sesquioxides of, p.42
— processing of, research on
— purification of TRU product, pp.37-8
TRANSURANIUM PROCESSING PLANT — operation of, pp.36-7 (D.H.M.)

53067 (ORNL-4794, pp 88-90) SURFACE AND INTERFACE PROPERTIES IN HETEROGENEOUS SYSTEMS. Aug 1972.

In Chemical Technology Division annual progress report for period ending March 31, 1972.

Research progress is reported on: isotope enrichment by (n,γ) reactions in molecular sieves, oxidation of colloidal urania, and theoretical model of colloidal interaction. (D.H.M.)

53068 ATTEMPTS OF REACTOR LOOP USE FOR ^{125}I PRODUCTION. Kulesza, Albin; Lada, Witold; Michalik, Jacek (Instytut Badan Jadrowych, Swierk, Poland). Nukleonika; 16: No. 11-12, 565-71(1971). (In Polish).

Attempts at production of ^{125}I by natural xenon activation in a reactor gas loop are described. Active xenon removal by liquid nitrogen cooling in a pressure vessel is described. The ^{125}I was extracted from the liquid by distillation. The yield of the reactor gas loop method is considered. The radiation purity of the product amounted to more than 99%. (auth)

53069 EXTRACTION OF ^{32}P FROM NEUTRON-IRRADIATED SULFUR DISSOLVED IN HOT TOLUENE. Domondon, D. B.; Ocon, F. T.; Valdezco, J. L. (Philippine Atomic Research Center, Diliman). Philipp. Nucl. J.; 2: No. 2, 197-203(1970).

The method (Method I) currently in use at PARC for routine processing of ^{32}P and two alternative methods (Method II and Method III) of extracting ^{32}P from neutron-irradiated sulfur dissolved in hot toluene are described. Method I is liquid-liquid extraction using pure water as extractant. Two consecutive extractions give about 75% of the total ^{32}P content. Method II consists in refluxing the hot toluene solution with powdered magnesia, after which the spent toluene solution is removed from the extraction flask. The magnesia is washed successively with fresh toluene, alcohol and water, then dissolved with HCl. The extract contains 90% or better of the initial ^{32}P content. In Method III, hot toluene is made to trickle over irradiated sulfur placed on top of a column of magnesia. The sulfur is dissolved and the ^{32}P quantitatively retained on the magnesia. The magnesia is washed and dissolved as in Method II. A yield of 95% or better is obtained. The ^{32}P extracts from the different methods are purified in the same way. After filtration, the extract is passed through a cation exchanger to remove cationic impurities, treated with H_2O_2 to destroy organic impurities, then the ^{32}P is taken up in pyrogen-free, distilled H_2O. (auth)

53070 CARRIER-FREE ^{131}I FROM TELLURIC ACID. Montesa, Elizabeth F. (Philippine Atomic Research Center, Quezon City). Philipp. Nucl. J.; 2: No. 2, 205-10(1970).

Carrier-free ^{131}I, suitable for medical use, was prepared by the wet distillation of telluric acid. Telluric acid in aluminum cans was irradiated intermittently in the Philippine Research Reactor (PRR-1) up to a maximum of 250 hours. After dissolution of the irradiated telluric acid in sulfuric acid, hydrogen peroxide was added and ^{131}I was distilled into a dilute solution of sodium hydroxide. Chromatographic examination of the product showed it to be primarily iodide (99 to 99.5%) with negligible amounts of periodate and iodate; half-life determinations gave an average value of 8.07 days and gamma spectrometry using a 256 channel analyzer exhibited the peaks of ^{131}I only. (auth)

53071 PREPARATION OF ADHERENT ^{241}Am ALPHA SOURCES BY ELECTRODEPOSITION. Iwinska, Hanna (Instytut Badan Jadrowych, Swirk, Poland). Nukleonika; 17: No. 1-2, 69-73(1972). (In Polish).

The method of preparation of thin layer α sources by electrodeposition from 0.1M H_2SO_4 solution is described. The conditions of electrolysis were: pH = 3.7, time-110 min. The maximal activity obtained on platinum cathode was about 100 $\mu Ci/cm^2$. After ignition adherent coatings were obtained. (auth)

53072 REMOVAL OF MATERIALS FROM ION EXCHANGE RESINS. Dietrich, Lee A.; Dikeman, John C.; Johnson, Kenneth R. (to United States Atomic Energy Commission). U. S. Patent 3,669,631. 13 Jun 1972. Filed 8 Jan 1970.

A process is described for recovering radioisotopes from spent ion exchange resins that comprises mixing a spent ion exchange resin with an acidic solution containing a catalyst and hydrogen peroxide, heating the mixture to initiate an exothermic reaction, and maintaining the mixture at the reaction temperature until the reaction is complete with the resin entrapped materials dissolved. (auth)

53073 RECOVERY OF ^{238}Pu IN THE MILLI LABORATORY. Koch, G.; Ochsenfeld, W. (Kernforschungszentrum, Karlsruhe, Ger.). KFK-Nachr.; 3: No. 1, 9-11(1972). (In German).

Within the framework of the Plutonium-238 Program, which is part of the Actinide Project, NpO_2 (10%) iron cermet pellets in Zircaloy capsules were irradiated in the BR-2. After the cooling period, these pellets were transferred to the MILLI laboratory for chemical reprocessing and plutonium recovery. As the facility was originally designed for reprocessing SNR fuel elements, there is no ion exchange equipment within the heavily shielded part of the laboratory. Thus an extraction procedure had to be developed that uses tributyl phosphate (TBP), as is usually done in nuclear fuel reprocessing. The experience gained in the reprocessing of the first test charge by the newly developed procedure is described. (GF)

53074 EFFECT OF THE CHEMICAL PREPARATION OF ^{45}Ca ON THE NONPROTEIN BOUND SERUM FRACTION. Giuliano, C. (Institut National de la Sante et de la Recherche Medicale, Paris). Pathol.-Biol.; 29: No. 3-4, 205-11(Feb 1972). (In French).

The fraction of nonprotein bound calcium was measured simultaneously for stable ^{40}Ca and radioactive ^{45}Ca using the ultracentrifuge method. The amount of ^{45}Ca present varied with the method of preparation. Neutron activation of $^{44}CaCO_3$ led to the simultaneous production of ^{46}Sc and ^{45}Ca. These elements could be separated either by complexometry or by fractional chemical precipitation, the first method resulting in a higher rate of production for nonprotein bound ^{45}Ca than nonprotein bound ^{40}Ca. Some of the ^{45}Ca may be already complexed with an organic molecule in the ^{45}Ca mother source. In this case, possible modifications in the degree of metabolization of the ^{45}Ca tracer must be taken into consideration. (France)

53075 APPARATUS FOR PRODUCING GASEOUS FISSION PRODUCTS, PARTICULARLY ^{133}Xe. U. S. Patent 3,680,284. 1 Aug 1972.

A method and an apparatus are described for the commercial production of gaseous fission products without contamination by foreign gases. For ^{133}Xe production, a U compound of low melting point (such as prepared by dissolving UO_2 in molten sodium pyrosulfate) is irradiated by neutrons in an evacuated steel container. After irradiation, the target is melted, the container pierced, and the released gases led to a carbon trap. Then the trap is heated to release the rare gases, while retaining the iodine. ^{37}Ar may also be produced from the $^{40}Ca(n,\alpha)$ reaction using $NaF-CaF_2$ or $NaCl-CaCl_2$, or tritium from the $^{6}Li(n,\alpha)$ reaction using $LiCl-NaCl$ or $LiCl-CaCl_2$. (D.L.C.)

53076 EXTRACTION OF IRON, COBALT, AND MANGANESE FROM HYDROCHLORIC ACID WITH QUATERNARY AMINE ALIQUAT-336. Aly, H. F.; El-Garhy, M.; El-Reefy, S. Microchem. J.; 17: No. 4, 431-5(Aug 1972).

The extraction of iron, cobalt, and manganese by Aliquat-336 from HCl media was investigated. Dependence on both HCl and amine concentration was studied. The separation factors between iron and both cobalt and manganese were determined and optimum conditions for separation are given. Two procedures for separation of carrier-free ^{59}Fe from irradiated cobalt target and ^{54}Mn from irradiated iron target are given. The products obtained were more than 99% radiochemically pure. (auth)

Reactor Fuel Reprocessing

Refer also to abstract 52977.

53077 (CONF-720823-9) EFFECT OF EXTENDED EXPOSURE TO SIMULATED LMFBR FUEL REPROCESSING OFF-GAS ON RADIOIODINE TRAPPING PERFORMANCE OF SORBENTS. Ackley, R. D.; Davis, R. J. (Oak Ridge National Lab., Tenn.). 1972. 15p. Dep. NTIS.

From twelfth air cleaning conference; Oak Ridge, TN. (28 Aug 1972).

For LMFBR fuel reprocessing plants, a required radioiodine retention factor of $\sim 10^8$ is projected. Also projected is a cumulative retention factor of $\sim 10^6$ for iodine fixation achieved upstream of the filter-adsorber assembly used for final off-gas treatment. Thus, this assembly will need to provide a decontamination factor (DF) of $\sim 10^2$, but considerable reserve capability is desired. Certain silver-containing sorbents in a 2-in. depth at 100°C and/or 200°C have, in short-term laboratory tests, exhibited DF's of $>10^3$ for iodine as methyl iodide or elemental iodine under conditions including 3 vol % water vapor and iodine loadings estimated equivalent to that for at least one year of operation. Present objectives are to obtain information on the effective service life of such sorbents and to ascertain the desirability of locating a catalytic oxidation bed upstream of the sorbents to minimize poisoning by organics and to convert organic iodides to I_2. Accordingly, a laboratory facility for exposing sorbents to simulated fuel reprocessing off-gas is being operated. The main air stream is humidified to around 85% saturation (referred to room temperature). Elemental iodine (60-day ^{125}I-labeled), dodecane, and nitric oxide are continuously injected at their anticipated concentrations. One group of sorbents is exposed to untreated off-gas while another group is exposed to off-gas that has traversed a Hopcalite bed at 350°C. Methyl iodide (12.3-hr ^{130}I-labeled) is injected periodically to furnish short-term results, whereas long-term cumulative results are obtained with the I_2. Sorbents investigated include three varieties of silver zeolite (designated AgX with the percent Ag^+ for Na^+ exchange denoted), GX135 (silver salt-treated alumina-silica), and a type of iodized charcoal. Sorbent depths are 2 in. Excellent performance (indicated I_2 and CH_3I DF's $\geq 10^3$) was observed for the following test situations: 26% AgX, $\frac{1}{16}$ in. pellets, at 200°C, both with and without Hopcalite upstream, 196 days exposure; 99% AgX, $\frac{1}{16}$ in. pellets, 100°C, both with and without Hopcalite, 105 days; GX135 (8 × 16 mesh, U.S.), 200°C, with Hopcalite, 196 days; and GX135, 100°C, without Hopcalite, 119 days. (Data are not yet available for GX135, 100°C, with Hopcalite). Performances observed for other test situations ranged from poor to good. The importance of sorbent particle size was demonstrated by the less favorable performance of 88% AgX, $\frac{1}{8}$ in. pellets, 100 and 200°C, relative to that for the 26% AgX, $\frac{1}{16}$ in. pellets (200°C). The use of Hopcalite was highly beneficial in trapping iodine injected as CH_3I; in trapping iodine injected as I_2, its use was beneficial for 26% AgX, 99% AgX, and GX135 and deleterious for 88% AgX ($\frac{1}{8}$ in. pellets) and iodized charcoal (the latter at 66°C). This investigation is being continued. (auth)

53078 (CONF-720823-11) DETERMINATION OF THE RADIOACTIVE NUCLIDES PRESENT IN THE OFF-GAS STREAM GENERATED BY THE HEAD-END STEPS IN REPROCESSING HTGR TYPE FUELS. Lowrie, R. S.; Fitzgerald, C. L.; Vaughen, V. C. A. (Oak Ridge National Lab., Tenn.). 1972. 15p. Dep. NTIS.

From twelfth air cleaning conference; Oak Ridge, TN. (28 Aug 1972).

Results of studies to determine the behavior of radioactive nuclides in gaseous waste streams generated during the reprocessing of spent High Temperature Gas-Cooled Reactor (HTGR) fuel are presented. The fuel is in the form of coated particles of uranium and thorium, bonded into fuel sticks, and inserted into holes in large hexagonal graphite blocks. Spent fuel is reprocessed to recover the bred ^{233}U and the unburned ^{235}U. Studies were performed on a small scale in a hot-cell using a generalized head-end reprocessing flowsheet. The fuel specimens were crushed, burned to remove as much graphite as possible, and the burner residue separated into appropriate size fractions. Those fractions containing TRISO-coated particles were then ground to break the SiC coating and burned a second time. Residues from each fraction were leached with acid Thorex reagent. The off-gas from each step was collected and analyzed. Burning BISO-coated $(U\text{-}Th)O_2$ particles released the bulk of the ^{85}Kr (97 to 98%) and the tritium (98 to 99%); the remainder was released during the leaching step. The initial burning of the mixed TRISO-coated ThC_2 and TRISO-coated UC_2 fuel released ~7.4% of the ^{85}Kr. Subsequent grind-burn steps released an additional 7.4% of the ^{85}Kr from the ThC_2 particles and 84.5% from the UC_2 particles. Tests were completed on a fuel specimen containing TRISO-coated fertile ThC_2 particles and TRISO-coated fissile UC_2 particles. The initial burn released 20% of the tritium and less than 1% of the ^{85}Kr. Most of the tritium and ^{85}Kr in the fertile particles was released during the grinding step, the remainder in the burning and leaching steps. Grinding the fissile particle released most of the ^{85}Kr; the subsequent burning and leaching steps released the tritium and remaining ^{85}Kr. About 3.5% of the gross gamma activity present in the fuel stick was carried over by the off-gas streams during the burning tests. Although the primary sintered metal filters collected most of this activity, ~1% of the amount carried-over passed through the filter. Most (98%) of the tritium and ^{85}Kr present in spent HTGR fuel will be released during the grind-burn step in the head-end operations, although the amounts released during grinding or burning will depend on the fuel particle being processed. Further, small amounts of fission products do pass the primary sintered metal filter and may have to be removed by other means. (auth)

53079 (EUR-4812) EXTRACTION OF PLUTONIUM FROM HEAVY WATER FUELS BY THE SALTEX PROCESS. Heylen, P. R. (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)); Wurm, J. G.; Avogadro, A. (European Atomic Energy Community). 1972. 45p. (In French). Dep. NTIS (U. S. Sales Only).

A process known as the Saltex process was designed to extract plutonium from irradiated natural uranium fuel elements of the UO_2 (PuO_2)/Zircaloy type. It is essentially a head-end process based on pyrochemical reactions in molten salts for the recovery of a plutonium concentrate by precipitation and filtration. These operations are carried out in compact plants situated, in principle, in the same place as a group of power reactors. The uraniferous waste is treated and conditioned in such a way as to obtain insoluble material that can easily be stored permanently on the spot. The description of the flowsheet ends with a material balance sheet of products consumed and waste to be stored. (auth)

53080 (ORNL-4794) CHEMICAL TECHNOLOGY DIVISION ANNUAL PROGRESS REPORT FOR PERIOD ENDING MARCH 31, 1972. (Oak Ridge National Lab., Tenn.). Aug 1972. Contract W-7405-eng-26. 121p. Dep. NTIS.

Research is reported on: molten salt reactor processing; development of aqueous processes for LMFBR fuels; development of methods for reprocessing HTGR fuels; waste treatment and disposal; transuranium element processing; development of the thorium fuel cycle; preparation of $^{233}UO_2$ for light water breeder reactors; separations chemistry research; chemical applications of nuclear explosives; biochemical technology; spectrophotometric studies of solutions of lanthanides and actinides; preparation and properties of actinide oxides; surface and interface properties in heterogeneous systems; chemical engineering research; reactor evaluation studies; and miscellaneous programs. Separate abstracts were prepared for 15 of the 16 sections. Biochemical technology, not covered separately, includes macromolecular separations, high resolution analytical systems, water pollution studies, and miniaturized fast analyzer. (D.H.M.)

For abstracts of individual sections see: 52986, 53036, 53063, 53066, 53067, 53081–53085, 53128, 53552–53554, and 55197.

53081 (ORNL-4794, pp 1-14) MOLTEN-SALT REACTOR PROCESSING. Aug 1972.

In Chemical Technology Division annual progress report for period ending March 31, 1972.

BISMUTH — solvent properties of liquid, for rare earths and thorium, pp.4–5
EXTRACTION APPARATUS — interface detector for, salt–metal, p.12
MOLTEN SALT BREEDER REACTOR — fuel reprocessing for, design and construction of molybdenum reductive extraction equipment for, pp.11–12
— fuel reprocessing for, research progress on
PROTACTINIUM — precipitation as oxide from molten salts, pp.5–6
RARE EARTH ALLOYS AND SYSTEMS — rare earths–Th, solubility in liquid bismuth, pp.4–5
RARE EARTHS — separation from MSBR fuel salt by metal transfer process, pp.7–8
— separation from MSBR fuel salt by metal transfer process, contactor studies for, pp.8–9
REACTOR FUELS — reprocessing of MSBR, research progress on
— reprocessing of MSBR, chemistry of fuel reconstitution in, p.6
— reprocessing of molten salt, axial dispersion in simulated continuous fluorinator for, pp.9–10
— reprocessing of molten salt, development of frozen-wall continuous fluorinator for, pp.10–11
URANIUM — distribution between liquid bismuth and MSBR fuel salt, pp.6–7

—separation from molten fluoride salts by oxide precipitation, p.12–14
URANIUM FLUORIDES UF_6—reactions with uranium tetrafluoride in molten beryllium fluoride–lithium fluoride–thorium fluoride, p.6 (D.H.M.)

53082 (ORNL–4794, pp 15-25) DEVELOPMENT OF AQUEOUS PROCESSES FOR LMFBR FUELS. Aug 1972.

In Chemical Technology Division annual progress report for period ending March 31, 1972.

FISSION PRODUCTS—separation of volatile, in reprocessing of LMFBR fuels by voloxidation, pp.17–20
IODINE—separation of fission product, from off-gases in reprocessing of LMFBR fuel, pp.21–2
LIQUID METAL FAST BREEDER REACTOR—fuel reprocessing for, development of aqueous methods for
—fuels for, radiation properties and shielding requirements of, pp.22–3
RADIOCHEMICAL PROCESSING PLANTS—effluent control from, pp.24–5
REACTOR FUELS—thermal conductivity of sheared prototype LMFBR, p.16
—radiation effects on dissolution characteristics of LMFBR, pp.20–1
SHIELDED CONTAINERS—development for shipping irradiated LMFBR fuel, pp.15–6
TRITIUM—separation from off-gases in reprocessing of LMFBR fuel, pp.21–2 (D.H.M.)

53083 (ORNL–4794, pp 26-32) DEVELOPMENT OF METHODS FOR REPROCESSING HTGR FUELS. Aug 1972.

In Chemical Technology Division annual progress report for period ending March 31, 1972.

Research progress is reported on: head-end reprocessing studies with unirradiated fuel, head-end reprocessing studies with irradiated fuel, engineering studies of burner off-gas decontamination, and laboratory studies of burner off-gas decontamination. (D.H.M.)

53084 (ORNL–4794, pp 54-62) SEPARATIONS CHEMISTRY RESEARCH. Aug 1972.

In Chemical Technology Division annual progress report for period ending March 31, 1972.

Research is reported on: new separation agents, plutonium purification with amines, recovery of uranium from commercial phosphoric acid, extraction of lithium from salt solutions, high resolution rare earth separations, and distribution equilibria and mechanisms in uranium extraction by primary amine from sulfuric acid solutions. (D.H.M.)

53085 (ORNL–4794, pp 91-5) CHEMICAL ENGINEERING RESEARCH. Aug 1972.

In Chemical Technology Division annual progress report for period ending March 31, 1972.

Research progress is reported on: thorium anion exchange with very small resin particles, multicomponent mass transfer in electrolyte systems, mass transfer of water from sol droplets, production of sol-gel microspheres of small uniform size, chemical engineering research studies related to MSR processing, and recovery of tritium from blankets of controlled thermonuclear reactors. (D.H.M.)

53086 METHOD FOR REPROCESSING SPENT MOLTEN SALT REACTOR FUELS. McNeese, Leonard E.; Ferguson, Don E. (to United States Atomic Energy Commission). U. S. Patent 3,672,846. 27 Jun 1972. Filed 21 Apr 1970.

A method for reprocessing spent molten metallic fluoride salt mixtures suitable as molten salt breeder reactor fuels is provided wherein uranium, protactinium and certain rare earths are removed from the spent salt mixture prior to recycle of the purified salt mixture back to the reactor. A major fraction of the uranium contained in the spent salt mixture is removed by fluorination with the uranium hexafluoride being reconstituted into the purified salt for return to the reactor. The remaining uranium and protactinium are removed in a protactinium isolation unit by reductive extraction into a molten bismuth solution containing lithium, thorium, and ^{233}Pa as metal reductants. The extracted uranium is carried out of the unit by the metal solution while the protactinium is held-up within the unit in the bismuth phase. The rare earths are then reductively extracted from the uranium and protactinium-free spent salt mixture in a rare earth removal unit into a molten bismuth solution containing lithium and thorium as metal reductants. The rare earths are then back extracted from the bismuth phase into an acceptor salt selected from lithium chloride, lithium bromide and their mixture. Hydrogen fluoride oxidizers are provided for removal of extracted materials, including fission products which form non-volatile fluorides during fluorination, metal corrosion products, and $^{231}PaF_4$, from the bismuth in order to regenerate the bismuth solution. Provision is also made for the separate recovery from the acceptor salt of divalent and trivalent rare earths. (auth)

53087 MILLI, A FACILITY FOR THE CHEMICAL REPROCESSING OF IRRADIATED SUBSTANCES. Leichsenring, C. H. (Kernforschungszentrum, Karlsruhe, Ger.). KFK-Nachr.; 3: No. 1, 6-9(1972). (In German).

MILLI is a facility established for chemical reprocessing of irradiated fuels and is now used for the extraction of uranium, plutonium, and other actinides, such as americium and curium. For this purpose, new extraction processes had to be developed. The name MILLI stems from the nominal throughput of the installation which is one milliton, i.e., 1 kg of irradiated uranium-plutonium fuel per day. Its mode of operation is outlined by describing the reprocessing of breeder fuels by a modified Purex process. The special requirements that had to be met by an appropriate shielding and by a criticality-proof design of the overall facility is described. This is followed by a short outline of the analytical process control, of waste gas, and solvent cleaning. (GF)

53088 CHEMICAL PROCESS ENGINEERING. FLUORIDE PROCESS AS AN ADVANTAGEOUS PROCESS IN FUEL REPROCESSING. 7. CHEMICAL PROCESSES IN THE DEVELOPMENT OF NUCLEAR TECHNOLOGY. Lanius, E. H. VDI (Ver. Deut. Ing.) Nachr.; 26: No. 14, 14(1972). (In German).

The advantages of a process for the enrichment of deuterium, which circumvents the corrosion problems that arise in the $HDS + H_2O \rightarrow H_2S + HDO$ method due to the high aggressiveness of the hydrogen sulfide are described. The technique discussed is the ammonia process, which makes use of countercurrent isotope exchange between hydrogen and ammonia, $(HD + NH_3 \rightarrow H_2 + NH_2D)$. This reaction needs the presence of a catalyst (dissolved potassium amide). The fuel reprocessing techniques used so far are based on selective countercurrent extraction of Pu and U from aqueous solutions into an organic phase. Further improvements of the fluorine technique will very likely lead to the fluoride process being preferred to aqueous reprocessing methods. (GF)

ENGINEERING

Energy Conversion

Refer also to abstracts 53117, 53335, 53337, and 53338.

53089 (AD-737380) DESCRIPTION OF HIGH-PRESSURE ELECTROFLUIDDYNAMIC (EFD) FACILITY. Final Scientific Report. Willke, Theodore L.; Fretter, Ernest F. (Aerospace Research Labs., Wright-Patterson AFB, Ohio). Nov 1971. 59p. (ARL-71-260). NTIS.

A facility is described which simulates EFD generator operation using high pressure air as the working fluid. The humidity, temperature, mass flow, and pressure of the air can be controlled and monitored in two nearly identical air systems. The working fluid is supplied to one of three high pressure list stands enclosing experimental EFD conversion channels. Excitation voltage of up to 150 kV and generate voltages up to 2000 kV are supplied. Types and specifications of various types of instruments are described as well as the types of experiments performed. (auth) (NTIS)

53090 (BNL-16889) METAL HYDRIDES FOR ENERGY STORAGE. Wiswall, R. H. Jr.; Reilly, J. J. (Brookhaven National Lab., Upton, N. Y.). 1972. 22p. (CONF-720925-6). Dep. NTIS.

From seventh intersociety energy conversion engineering conference; San Diego, CA. (25 Sep 1972).

The use of metal hydrides as hydrogen reservoirs facilitates the storage and subdivision of central-station power for automotive and other purposes. Hydrides with a wide range of properties have been synthesized and studied, and several appear to have promise for specific storage applications. Results are reported on the effect of alloy constituents on hydride stability; on the formation of hydrides by metals reacting with gas mixtures such as those produced by the steam reforming of hydrocarbons; and on the feasibility of integrated systems of hydride reservoir plus engine or fuel cell. (auth)

53091 (IPP-IV-36) PERFORMANCE OF MHD GENERATORS AND THE THERMAL EFFICIENCY OF CLOSED CYCLE MHD POWER PLANTS. Salvat, M. (Max-Planck-Institut fuer Plasmaphysik, Garching (West Germany)). Apr 1972. 22p. (In German). Dep. NTIS (U. S. Sales Only).

The thermal efficiency of a nuclear power plant incorporating a gas-cooled high-temperature reactor, a MHD-generator, a heat exchanger and compressors depends, among other things, on the polytropic efficiency of the MHD generator. Since the local polytropic efficiency is reduced by heat and friction losses, realistic cycle efficiency computations must take into account the variation of the local polytropic efficiency along the length of the MHD channel. It has been pointed out that for this type of power plant a Ne-Cs mixture seems to be more advantageous than a He-Cs mixture. Results of computations pertaining to the power output of a MHD generator and to the thermal efficiency of the cycle operating with Ne-Cs as working medium are presented. It is shown that for stagnation (reactor) pressure and temperature values of 30 atm and 2000°K (or 40 atm and 2150°K, respectively), the thermal efficiency is about 50%. (auth)

53092 (MMM-3691-5(Rev.1)) SNAP-21 PROGRAM, PHASE II. DEEP SEA RADIOISOTOPE-FUELED THERMOELECTRIC GENERATOR POWER SUPPLY SYSTEM. PRELIMINARY DESIGN DESCRIPTION 10-WATT SYSTEM. Wharam, J. (Minnesota Mining and Mfg. Co., St. Paul. Electrical Products Group). Feb 1967. Contract AT(30-1)-3691. 96p. Dep. NTIS.

SNAP-21 is a ^{90}Sr-fueled thermoelectric generator 10-W power system for providing electric power for use under the surface of the sea. The preliminary design, design and safety requirements, and a detailed description of the development and testing of all components of the system are presented. (L.C.L.)

53093 (NASA-TM-X-2440, pp 13-25) SPACE NUCLEAR POWER SYSTEMS. Carpenter, R. T. (Space Nuclear Systems Office, Washington, D. C.). Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

Space nuclear power systems have been, are being, and will be developed for use in those particular spacecraft applications for which nuclear power systems offer unique advantages over solar and/or chemical space power systems. Many of these advantages are discussed relative to the past and future applications of nuclear power systems in the space program. Both isotopic and reactor heated space electrical power units are described in an attempt to illustrate their operating characteristics, spacecraft integration aspects, and factory-to-end of mission operational considerations. Much experience has been gained with nuclear space power sources which have been flown. This experience is being used to guide current developments to make those units more attractive for operational use. The status of technology developments in nuclear power systems is presented. Some projections of these technologies are made to form a basis for the applications of space nuclear power systems to be expected over the next 10 to 15 years. (auth)

53094 (NASA-TM-X-2440, pp 26-33) NUCLEAR APPLICATIONS IN MANNED SPACE STATION. Brooksbank, W. A. Jr.; Sieren, G. J. (Marshall Space Flight Center, Huntsville, Ala.). Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

Current and future NASA Space Station studies will place a great deal of emphasis on economical systems which can start small and grow as the station itself grows. Space station electrical power systems based on nuclear sources will have to be increasingly adaptable to the lower power ranges to be competitive with other systems, while at the same time exploiting their inherent growth capability. Power growth capabilities as high as three of four-to-one will be required to meet the needs of a space station which is initially manned with a small crew and grows incrementally to a large station capable of accommodating a very complex experiment program. The zirconium hydride reactor, coupled to a thermoelectric or Brayton conversion system, and the ^{238}Pu isotope/Brayton system are considered to be the viable nuclear candidates for the modular space station electrical power system. The basic integration aspects of these nuclear electrical power systems, including unique requirements imposed by the buildup and incremental utilization considerations of the modular station, are reviewed. Also treated are the various programmatic aspects of nuclear power system design and selection. (auth)

53095 (NASA-TM-X-2440, pp 844-9) DESIGN CONSIDERATIONS FOR COMBINED RADIATION EFFECTS FACILITIES FOR TWELVE-YEAR OUTER PLANET SPACECRAFT VOYAGES. Miller, Charles G. (California Inst. of Tech., Pasadena). Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

The design considerations influencing the choice and utility of environmental simulation methods and facilities are described, insofar as they relate to the new requirements imposed on outer planet spacecraft because of radiation environments to be expected. Possible means for duplicating the radioisotope thermoelectric generator radiation environment, and for duplicating the effects of trapped radiation belt environment are described, together with an assessment of radiation levels to be expected in the vicinity of an environmental testing chamber when in use. (auth)

53096 (UCRL-51221) ENERGY: USES, SOURCES, ISSUES. Austin, A. L.; Rubin, B.; Werth, G. C. (California Univ., Livermore. Lawrence Livermore Lab.). 30 May 1972. 129p. Dep. NTIS.

Data on current and predicted future energy uses, costs, and sources are compiled as a reference for studies of the complex problems involved in providing the US with abundant supplies of low cost energy while minimizing the environmental effects of energy production and use. The data are presented in graphs or tables with the data sources itemized. (L.C.L.)

53097 POWER GENERATION OPTIONS FOR THE EIGHTIES AND NINETIES. Kent, M. F. Pub. Util. Fortn.; 90: No. 4, 17-23(17 Aug 1972).

An evaluation of power generation from sources such as fusion, solar energy, geothermal energy, magnetohydrodynamic reactions, fuel cells, breeder reactors, desulfurized coal, and hydrogen is presented. Generation options for the 1980-to-1990 period are discussed along with power needs in the U. S. during the period 1980 to 2000. (J.R.D.)

53098 TWENTY-TWENTY VISION: A VIEW OF THE FUTURE. Faust, George R. (Gilbert Associates, Inc., Washington, D. C.). Pub. Util. Fortn.; 90: No. 4, 24-32(17 Aug 1972).

The state of present technology related to gas and electric utilities is examined and the chances of using advanced technology in dealing with the problems associated with utility depreciation accrual rates are evaluated. Discussions are included on gas industry, coal gasification research, atomic energy, magnetohydrodynamics, fuel cells, and underground transmission lines. (J.R.D.)

53099 DETERMINATION OF THE MAGNETIC FIELD EXTENSION PROFILE FOR REDUCING THE END LOSSES IN THE MHD GENERATOR CHANNEL. Bajaria, Hansraj J. Houghton, Mich.; Michigan Technological Univ. (1972). 98p. University Microfilms Order No. 72-21,633.

Thesis.

A constant area rectangular channel was studied. The end power loss due to the leaking currents was computed on the basis of Ohm's law and with an empirical estimation of the leakage currents. The accuracy of this circuit-theory approach to estimate the end losses was verified over the wide range of parameters (aspect ratio, loading factor) with the well known solution based on the conformed mapping method. The equation of actual power developed was used as the key expression for the parameter studies (including aspect ratio, loading factor, magnetic field, etc.). The Laplace equation was shown to be the governing equation for the electric potential and current density distribution. Two main assumptions made were: velocity was constant across the channel and induced magnetic field effects were negligible due to magnetic Reynolds number being much smaller than unity or by the use of the backstraps. To solve the equation a numerical finite difference equation method was applied. Through Gauss–Seidel iteration procedure, the distribution profiles of the end current density with proper boundary conditions were obtained for different values of K in the equation $B = B_0 e^{-Ky}$. The current density profiles so obtained were compared to find the value of K corresponding to the optimum end loss compensation. The same procedure was repeated for different load factors varying from 0.2 to 1.0. Magnetohydrodynamic losses were discussed to show qualitatively the effects of overcompensation and incomplete compensation. It also showed the overcompensation could not mean the useful conversion of energy into electrical power as claimed by Sutton et al. Experimental results which have used the constant extension and exponential extension were cited to support the analysis. For the practical laboratory application of the present analysis, various shimming methods were suggested to modify the profile curve of the natural-decayed magnetic field to obtain the desired optimum shape. It was concluded that (i) the end power loss expression was quite adequate for the design and construction of the electro-mechanical set-up for a modern MHD power generator, and (ii) there was a definite optimum value of K corresponding to each loading factor which gave more complete end loss compensation; the value of K lower than the optimum value resulted in overcompensation, whereas higher values resulted in incomplete compensation. (Diss. Abstr. Int., B)

53100 ENERGY CRISIS: THE ISSUES AND A PROPOSED RESPONSE. McCloskey, Michael. Environ. Aff.; 1: No. 3, 587-605(Nov 1971).

The environmentalists' views, as opposed to industrialists' views, of the energy crisis are presented. Environmentalists contend that: the crisis lies in the need to halt excessive pressures for increased consumption; the present rate of energy growth is unrealistic, environmentally damaging, and artificially induced; and there are reasonable ways to bring this rate of energy growth under control. Arguments and data to support each of these contentions are discussed. (L.C.L.)

53101 LEGAL SOLUTION TO THE ELECTRIC POWER CRISIS: CONTROLLING DEMAND THROUGH REGULATION OF ADVERTISING, PROMOTION, AND RATE STRUCTURE. Permar, David H. Environ. Aff.; 1: No. 3, 670-93(Nov 1971).

Electric power generation and use in the U.S. is discussed with respect to the factors which contribute to growth in demand; economic incentives which stimulate the building of more new power plants; failure of regulatory controls; effects of advertising and promotional activities; rate structure of utilities; and suggested legal steps which could be taken to limit the growth of electric power generation. (L.C.L.)

53102 TOTAL ENERGY: POWER (NUCLEAR) AND DISTRICT HEATING. Aler, B. (Aktiebolaget Atomenergi, Studsvik, Sweden). Phil. Trans. Roy. Soc. London, Ser. A; 272: No. 1229, 627-37(27 Jul 1972).

An assessment is made of the possibilities of meeting the total future energy requirement of urban areas in Sweden by nuclear energy and comparisons are made with requirements in Great Britain. It is considered that nuclear power will supply a large proportion of the Swedish energy requirements by the 1980's provided either by combined nuclear heat and power plants located close to the major cities or by hot-water heated by bleed-off steam from large condensing nuclear plants in the neighborhood. Most of the electricity will be produced by nuclear power in the 1980's and its share will successively increase during the following decades. (UK)

53103 NON CONVENTIONAL TWO PHASE CYCLES IN AUTOTRACTION. Maizza, Vito (Univ., Bari, Italy). Termotecnica (Milan); 26: No. 2, 71-83(Feb 1972). (In Italian).

In view of a possible use of steam propulsion in autotraction, some of the techniques used to solve aero-space problems are reviewed and it is shown how autotraction may benefit by them. The problems related to the choice of the parameters of the operative cycles are pointed out and discussed. It is shown that pressure and temperature values within a narrow range and not too low are the most satisfactory for autotraction. Some working fluids, allowing high efficiency of operative cycles and exhibiting fast vaporization necessary for autotraction, are considered and their thermodynamic characteristics are discussed. The efficiencies of cycles using the above working fluids have been calculated and the results graphically presented. The latter are discussed with particular reference to condensation pressure and temperatures. It is then shown that there is a range in which pressures and temperatures should be kept to attain an advantageous combination of weight, size, plant and operating cost. Finally, the effect of the chosen parameters on the design of the various components in an automotive power plant is discussed. (auth)

53104 EXPERIMENTAL STUDY OF THE RELAXATION PHENOMENA IN NON-EQUILIBRIUM MHD GENERATOR DUCT. Ikegami, Tetsuo; Yoshikawa, Kiyoshi; Morimoto, Kenji; Numano, Masahiro; Michiyoshi, Itaru (Kyoto Univ.). J. Nucl. Sci. Technol. (Tokyo); 9: No. 8, 439-44(Aug 1972).

The non-equilibrium electrical conductivity and the relaxation of electron density in seeded plasma for MHD power generators were studied experimentally. The experiments were performed with use made of potassium seeded argon plasma (A + 0.14% K) at 1,800° ~ 2,000°K, flowing in a rectangular duct at constant velocity (about 240 m/sec) under atmospheric pressure. The dependence of the electrical conductivity on the electric current density was found to agree well with theoretical prediction based on the two-temperature model, if a value of 40 was chosen for the collision loss parameter. The effect of the radiative energy loss of potassium atoms was not significant in the present experiments. Furthermore, it was found that the relaxation of the electron density can be well expressed by the recombination coefficient for the electronic three-body recombination processes, and that the relaxation time is about 4×10^{-4} sec for the present experimental conditions. (auth)

53105 EFFECT OF HETEROGENEITY AND HALL CURRENT ON THE MHD POWER GENERATOR. Rudraiah, N.; Narasimha Murthy, S.; Chandrasekhara, B. C. (Univ. of Visvesvaraya, Bangalore, India). Jap. J. Appl. Phys.; 11: No. 9, 1372-9(Sep 1972).

The aim of the present investigation is to consider the influence of Hall effect on the performance of a liquid metal generator using a heterogeneous conducting fluid. The results show that the combined effect of Hall current and heterogeneity increases the electrical efficiency as well as output power of the generator for a given aspect ratio. (auth)

53106 PRESSURE DROP OF LIQUID MERCURY MHD POWER GENERATORS. Michiyoshi, Itaru; Nakura, Saburo (Kyoto Univ.). J. Nucl. Sci. Technol. (Tokyo); 9: No. 8, 490-6(Aug 1972).

Results of experimental studies of performance characteristics of both constant-area (34 × 7 × 295 mm) and diverging-area (23 × 7 to 43 × 7 × 295 mm) MHD power generators with liquid mercury as working fluid, with particular reference to the pressure drop created in the inlet and outlet ducts as well as inside the generator channel, are presented. Discussions are presented on the following aspects. In respect of the constant-area channel, pressure drop in laminar and turbulent flow inside the channel, transition Reynolds number for given Hartmann number, pressure drop in the inlet duct and eddy current created near the end of electrode, output electrical power. For diverging channel, applied magnetic field intensity required for zero pressure drop inside the channel, pressure distribution inside the channel, output electrical power in the case of zero pressure drop. The experimental conditions were as follows: $Re < 10^5$ and $Ha < 60$. (auth)

53107 ENERGIE IN DER KRAFTWERKSTECHNIK. LEISTUNGSREAKTOREN, DAMPFKRAFTWERKE, GASTURBINEN, WAERME-KRAFT-KOPPLUNG. (Energy in Power Plant Engineering. Power Reactors, Steam Power Plants, Gas Turbines, Heat, and Power). Kriese, S. Essen; Vulkan-Verl. Dr. Classen (1971). 176p.

A fundamental explanation of the term energy which represents the maximum of a given energy that can be used in thermal processes is followed by a section where this model is applied to some of the well-known thermodynamic processes. The efficiency of the energy conversion in power reactors and in a power unit is determined and explained within this framework. Moreover, the way of

setting up energy and energy flow sheets is outlined, illustrated by one example each. (GF)

53108 PROCESS FOR GENERATING ELECTRICAL ENERGY. Pozwolski, Alexandre Edgar. French Patent 2,093,020. 28 Jan 1972. Filed 25 May 1970. (In French).

A magnetohydrodynamic (MHD) electrical energy generator is described. This generator extends the direct conversion principle to exceptionally low temperatures (for this type of generator). A considerable specific power is obtained. Gas at high pressure is used as the working fluid (water vapor or methanol near or above its critical pressure). This gas is given a high electrical conductivity by dissolving at least one of the following strong electrolytes in it: KOH, KI, NH_4I, CH_3OK. (France)

Facilities and Equipment

Refer also to abstracts 53695 and 54461.

53109 (DP-MS-72-37) ^{252}Cf NEUTRON ACTIVATION FACILITY AT THE SAVANNAH RIVER LABORATORY. Peterson, S. F. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). 15 Aug 1972. Contract AT(07-2)-1. 6p. (CONF-720902-3). Dep. NTIS.

From National topical meeting on the applications of ^{252}Cf; Austin, TX. (11 Sep 1972).

A neutron irradiation facility has been established to develop new analytical methods and for the support of research programs. A major component of this facility is a ^{252}Cf source which provides both fission spectrum and thermal neutrons. (auth)

53110 (ORNL-TM-3841) VTE-X MODEL TEST AND COMPUTER CALCULATION OF ROW BY ROW PERFORMANCE AND COMPARISON WITH MEASURED DATA. Van Winkle, R. (Oak Ridge National Lab., Tenn.). Aug 1972. Contract W-7405-eng-26. 42p. (CONF-710555-1). Dep. NTIS.

From VTE-X symposium; Washington, D. C. (26 May 1971).

Comparisons are made between the observed performance of the VTE-X tube bundles during Oct. 1970 to Feb. 1971 and predictions based on model tests and general literature information. A summary is given of steam-side friction factors for enhanced VTE bundles and good agreement gained with VTE-X data. Tests of a 1/6-scale flow model of the VTE-X bundle showed good velocity distribution outside the tubes when the side gaps were at their design value, but recirculation was observed at twice design value. VTE-X heat transfer data from individual clusters are related to process conditions and to the presence of noncondensables. (auth)

53111 (RDT-E-1-13-T(8-72)) VALVE, ISOLATION, BUTTERFLY TYPE. (Division of Reactor Development and Technology (AEC), Washington, D. C.). Aug 1972. 11p. RSO.

A standard prescribing requirements for butterfly-type isolation values for nuclear and associated applications is presented. This standard supersedes RTD E1- 13T dated December 1970. (J.R.D.)

53112 (RDT-F-8-6-T(8-72)) HOISTING AND RIGGING OF CRITICAL COMPONENTS AND RELATED EQUIPMENT. (Division of Reactor Development and Technology (AEC), Washington, D. C.). Aug 1972. 30p. RSO.

A standard prescribing requirements for hoisting and rigging of critical components and related equipment for nuclear and associated applications is presented. (J.R.D.)

53113 (Y-DA-4541(Rev.1)) PRACTICAL DESIGN CONSIDERATIONS FOR THE APPLICATION OF GAS BEARINGS TO MACHINING PROCESSES. Steger, P. J. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). 1972. Contract W-7405-eng-26. 14p. (CONF-720918-1). Dep. NTIS.

From thirteenth international machine tool design and research conference; Birmingham, England (18 Sep 1972).

Application of gas bearings to the machining process can provide important advantages in performance and operational reliability. It is important in the design to consider the practical aspects of fabrication, assembly, and maintenance if these advantages are to be fully realized. Externally pressurized gas-bearing-supported machine tool and gaging machine components were developed and applied to machining processes. Implicit in the designs was the selection of easily fabricated geometries, stable structural systems, and a material compatibility which enhanced the bearing reliability. Bearing runouts of from 5 to 25 μ in., part load capacities of from 1,000 to 7,000 lb, and inherent stiffnesses of 50 lb/μ in. have been readily obtainable. Operating experience indicates that gas bearings, using the design and fabrication techniques and procedures discussed, are both practical and economically feasible for production machine tools under moderate operating conditions. (auth)

53114 CALCULATION OF THE DYNAMIC BEHAVIOR OF HEAT EXCHANGERS IN GAS TURBINES. Bammert, K.; Klaeukens, H. Forsch. Ingenieurw.; 38: No. 1, 1-8(1972). (In German).

The dynamic behavior of the heat exchangers plays a major part in the control of nuclear-heated gas turbines of the enclosed type. Two methods have been developed which offer the possibility of performing the corresponding calculations with a digital computer. Programs have been elaborated for each method, with the first yielding a high degree of accuracy, requiring sufficiently small intervals, whereas the second program offers the advantage of a shorter computing time due to larger intervals for those cases where the degree of accuracy is not of prime importance. (INIS)

53115 MEASUREMENTS ON A FUEL-SALT INTERFACE IN THE ANNULAR WELL SPACE DURING THE PRODUCTION OF A CAVITY BY SALT DISSOLUTION. Donat, G.; Tellier, C. (Gaz de France, Paris). Rev. Inst. Fr. Petrole Ann. Combust. Liquides; 26: No. 12, 1203-11(Dec 1971). (In French).

The exploitation of two underground pressurized natural gas reservoirs created at Tersanne (Drome) has begun. These reservoirs are in the form of two cavities having volumes of 100,000 and 130,000 m^3, the gas being stored at a depth of 1,400 m and at a pressure of 220 bars. Each cavity was formed by vertical leaching from a cemented tube constructed between the top of the salt layer and the surface. An annular volume around this tube was filled with a substance, which did not react with the salt (fuel). In this way the dissolution in the upper part of the cavity was controlled. These results were obtained by successive leaching operations, each operation corresponding to the dissolution of a given depth of the exposed area. The depth of the fuel-salt interface was found using γ ray detection techniques after having injected a quantity of ^{82}Br-labeled water into the outer annular volume. (France)

53116 PLUGGING TEMPERATURE INDICATORS (28 Dec 1970) (Engineering Materials). (Richland Operations Office (AEC), Wash.). (CAPE-2251).

5 drawings.

A stacked foil filter and an orifice plate plugging device are temperature indicators which determine the temperature of liquid-metal systems, where plugging of the system is likely to occur from precipitation of the impurities in the liquid metal. In operating the indicators, the liquid metal is cooled below the saturation temperature of the impurities, where nucleation and precipitation of the impurities in the filter or orifice plate occur, producing a decrease in the flow rates through the device. The temperature at which the flow loss occurs is referred to as the plugging temperature (P.T.). The indicators, when used in the single-cycle mode, give a P.T. lower than the actual P.T. because impurities dissolved in the liquid metal become supersaturated before precipitation occurs. When the indicators operate in the oscillatory mode, P.T. values agree more closely with the true saturation temperature. When operated in this mode, the reproducibility is ±10% in the P.T. range of 300° to 400°F. The indicators were evaluated over bulk sodium temperatures of 400° to 1500°F and a P.T. of 300° to 450°F. These devices indicate gross impurities and they are not necessarily specific for a single impurity. The P.T. determinations below a saturation of 300°F are difficult and time consuming, requiring several hours for determination. The stacked foil filter indicator consists of a series of stacked discs. Sodium enters the indicator and flows down an outer annulus. Flowing sodium separates at the filter end of the indicator: one flow path is through the filter and the flow return is through another annulus which serves as a bypass flow. Bypass and filter flow rates are recorded on two strip recorders. The temperature of the filter is recorded on the same strip chart recorder as the filter flow rate. In the other indicator, Na enters the indicator through a center tube and loses heat to the Na flowing up the outside annulus. A thermowell and a thermocouple monitor the temperature of the orifice plate. Flow rate and orifice temperature are recorded on a strip chart with a dual pen recorder. (For details see TID-4100 Suppl.72). (F.S.)

53117 FORMATION OF FOG AND GLAZED FROST DUE TO COOLING-TOWER OPERATION. Bach, H. (Deutscher Wetterdienst-Wetteramt, Essen). Tech. Mitt.; 65: No. 5, 230-6(1972). (In German).

The topics reviewed are operational data on evaporation and drift loss in wet cooling; atmospheric exchange processes within the tower region; absorption capacity of the environmental air; meteorological conditions; changes of the microclimate; definition of the radius of action; and suitable arrangement and construction of cooling towers. (GF)

53118 CONSTRUCTION AND CALIBRATION OF A STANDARD THERMAL NEUTRON FLUX FACILITY. Ryves, T. B. (National Physical Lab., Teddington, Eng.). J. Inst. Nucl. Eng.; 13: No. 3, 74-7(1972).

A thermal neutron flux density standard in excess of 10^7n $cm^{-2}s^{-1}$ was produced with high stability and a very small flux gradient at the irradiation position. The standard thermal neutron flux was produced from sources of fast neutrons consisting of beryllium targets bombarded by a 3-MeV deuteron beam from the Van de Graaff accelerator, moderated in a large graphite block. The standard thermal neutron flux density was measured by activation of bare and cadmium covered thin gold foils. Activation was interpreted by means of the Westcott (1958) method using renormalized expressions for the epithermal flux density to fit the assumed epithermal spectrum. The 2200 ms^{-1} activation neutron capture cross section of about 30 other isotopes were measured relative to gold in the facility. Most accurately measured were ^{23}Na, ^{27}Al, ^{37}Cl and ^{51}V with random plus systematic errors of 1 to 2%. The main experimental difficulty was in determining the absolute foil activities. Where possible β/γ coincidence counting was used. (UK)

Heat Transfer and Fluid Flow

Refer also to abstracts 53110, 53114, 55174, 55179, 55180, 55188, and 55449.

53119 (AREAEE-122) THERMAL EQUILIBRIUM OF A BUBBLE NEAR A HEATED SOLID SURFACE AND ASSOCIATED FLOW PATTERN. Gaddis, E. S. (Atomic Energy Establishment, Cairo (Egypt). Reactors Dept.). 1971. 33p. Dep. NTIS (U. S. Sales Only).

A model is presented that yields the conditions under which thermal equilibrium of a vapor bubble near a heated solid surface can be attained. In the model, liquid motion induced by the evaporation and condensation at the bubble surface as well as variation of surface tension with variation of temperature of the interface were considered. Numerical results are presented as well as a typical distribution of the stream lines of the associated liquid flow pattern. (auth)

53120 (CEA-R-4318) INTERDIFFUSION, IN THE REGION OF CONTINUUM FLOW, OF BINARY GASEOUS MIXTURES INSIDE INHOMOGENEOUS POROUS MEDIA. APPLICATION TO THE EVALUATION OF THE TRANSPORT COEFFICIENTS BY MEANS OF DEVAUX EFFECT. Breton, Jean-Paul (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Jun 1972. 33p. (In French). Dep. NTIS (U. S. Sales Only).

The general transport equations for binary mixtures are applied to the problem of interdiffusion in porous media. The fluxes of the two gases are first calculated as functions of the characteristics of the gases and of the porous medium. Then this derivation is generalized to the case of inhomogeneous media. Finally, an interesting example is studied, namely the Devaux effect, from which one can evaluate simultaneously the diffusive and convective resistances of the porous medium. (auth)

53121 (CONF-710959-, Paper 7) ACTIVATED MATERIAL TEST LOOP. 4p.

From Meeting on fission and corrosion product behaviour in primary systems of LMFBR's; Bensberg, Germany (20 Sep 1971).

A sodium mass transfer test loop is described in which activated material is used as a part of specimen in studies of activation to clarify mass transfer phenomenon and to observe behavior of corrosion product and activated Na in liquid Na and to obtain data for design, operation, and maintenance of FBR. So far three cold test runs covering 500 hours, 500 hours, and 1,000 hours were conducted. An initial 1,000 hour hot test run is scheduled for August. (auth)

53122 PHOTOGRAPHIC STUDY OF TWO-PHASE HIGHLY DISPERSED FLOWS. Cumo, Maurizio; Ferrari, Giuseppe; Farello, Giovanni Elvio (CNEN-CSN, Rome). Termotecnica (Milan); 25: No. 9, 450-8(Sep 1971).

A post-burnout two-phase flow of a highly dispersed mixture of Freon-12 (reduced pressure 0.3) was analyzed by mean of high-speed (40,000 ph.p.s.) cinematography. The Freon was electrically heated in a section of a loop and then, moved downward from the heating section, into a sight section through which high-speed films were taken. The photograms were analyzed taking into account such droplet population characteristics as droplet dimensional distribution, droplet velocity, and trajectories. The main conclusions were: there is photographic evidence of a thermodynamic disequilibrium up to the calculated qualities of 200% in post burnout two phase flows; the droplet mean dia decreases with increasing heat flux (the test section was uniformly heated by Joule effect) and the vapor mass velocity; the droplet velocity is independent of droplet dia and is almost the same for all droplets (theoretical equations of droplet entrainment were confirmed); the droplet velocity transversal profiles are very close to those theoretically deduced for the vapor (the local slip ratios are very close to 1); and droplet trajectories (graphically deduced from the photograms and plotted) are straight and parallel to the flow. Many diagrams of droplet dimensional distribution versus mass velocity, versus quality and versus heat flux were plotted; the investigation involved more than 10,000 droplets. As the flowrate and the heat flux increase the dimensional distribution curves tend to move toward the smallest diameters. (auth)

53123 OBSERVATION ON THE CISE CRITERION FOR THE EXTENSION OF THE CRITICAL HEAT FLUX TUBE CORRELATION TO THE ROD BUNDLE GEOMETRY. Gaudiosi, Gaetano (CNEN-CSN, Rome). Termotecnica (Milan); 26: No. 2, 89-104(Feb 1972).

The CISE criterion for the extension of the Critical Heat Flux (CHF) tube correlations to the rod bundle geometry is presented. Some additional refinements are suggested. The criterion was applied to the CISE and Becker CHF tube correlations. The proposed subchannel CISE and Becker correlations have been preliminarily compared to the former mixed flow correlations, to some Hambo and Cobra thermohydraulic subchannel code results, and to some experimental data for a uniform heat flux distribution. The two last proposed rod bundle correlations show correct trends and results. However, a more complete comparison is needed to check their accuracy. (auth)

53124 SOME BASIC EXPERIMENTAL METHODS OF WET-STEAM FLOW INVESTIGATION. Stastny, Miroslav; Falout, Frantisek; Tajc, Ladislav; Zeleny, Josef; Plzen, N. P. Energetika; 22: No. 6, 249-55(Jun 1972). (In Czech).

Basic experimental apparatus and measuring methods for the investigation of the two-phase steam-water flow in which the prevailing steam component and the liquid phase in the form of water drops, which is a typical case at some power-generating plants, especially at the light-water reactor turbines, are discussed. The experimental investigation of the wet-steam flow was made on experimental as well as on full-scale turbines and in the two-phase tunnels. Some types of pressure probes serve to measure the parameters of the steam component of the two-phase flow in the turbines and an optical probe for water-film investigations are mentioned. The determination of the mean moisture content from the balance and the visual observation of the liquid-phase motions belong to the basic measuring methods to be used in the two-phase tunnels. The use of the method based on the temperature-difference measurements between the liquid and the steam can be made when detecting the presence of the water drops in the reheated steam. The investigation of the water drops dispersed more coarsely is to be made using the impact method. (auth)

Materials Testing

Refer also to abstracts 53599, 55221, and 55222.

53125 EDDY CURRENT TESTING OF STAINLESS STEEL FUEL JACKET CLADDING TUBING. Ito, Hideyuki; Uetake, Ichizo (National Research Inst. for Metals, Tokyo). Hihakai Kensa; 21: No. 6, 344-54(Jun 1972). (In Japanese).

Eddy current testing of 316 stainless steel tubing using an instrument with single coil and precise impedance bridge is described. Bridge output signals are separated by a filter into a signal which indicates defects; the other gives information about metallurgical and dimensional variations. Testing and coil impedance measurements are carried out over frequency range 300 kHz to 1.25 MHz. Optimum condition for defect detection, test frequency, bridge balancing, filter frequency, and testing speed was determined experimentally. From the results obtained by micrographic examination of the parts where the defect indications appeared, it proved that the instrument successively detects a small defect (25μ in depth, inner surface defect). The effects of defect distribution on the signal and noise due to the ferromagnetic precipitate appearing in several tubes after heat treatment are described. (auth)

53126 DETECTION OF FAULTS IN METALLIC WELDS USING ULTRASOUNDS. Saglio, Robert (to Commissariat a l'Energie Atomique). French Patent 2,093,406. 28 Jan 1972. Filed 12 Jun 1970. (In French).

A method of examining welds using ultrasound is presented. The method involves measuring the time between the incident echo and the corresponding return echo (in the case of a defect). The measurements are effected by the positioning of the sensors relative to the part examined. With respect to the incident transverse waves, each sensor is displaced along a rectilinear path inclined at an angle β to the interface. β is a constant depending on the value of the angle of incidence α of the transverse waves, the velocity of the longitudinal waves in water, and the velocity

of the transverse waves in the part examined (steel, Al, etc). If longitudinal waves are used to examine the material (delta technique), then β is also a function of the longitudinal velocity of the waves in the material. (France)

Nuclear Explosions

Refer also to abstracts 53115, 53137, 53303, and 53316.

53127 (CEA-R-4288) TEMPERATURE DISTRIBUTION AFTER AN UNDERGROUND NUCLEAR EXPLOSION IN A GRANITE TERRAIN. Lavollee, Philippe (Commissariat a l'Energie Atomique, Bruyeres-le-Chatel (France). Centre d'Etudes). Jul 1972. 38p. (In French). Dep. NTIS (U. S. Sales Only).

The phenomenology of an underground nuclear explosion enabled the volume of rock containing the calorific energy, just after the explosion, to be defined. Analysis of heat transfer by conduction from the hot zones crosschecked with experiments performed in a granite mass, allowed analytical experiments for the heat transfer to be established. Comparison of the experimental results from various different media permitted the effects of the physicochemical composition of the terrain on the heat transfer to be established. (France)

53128 (ORNL-4794, pp 63-4) CHEMICAL APPLICATIONS OF NUCLEAR EXPLOSIVES. Aug 1972.

In Chemical Technology Division annual progress report for period ending March 31, 1972.

Research is reported on: studies of the behavior of radionuclides in natural gas storage reservoirs and the disposal of tritiated water solutions that are generated in gas stimulation and gas storage applications. (D.H.M.)

53129 (UCRL-Trans-10616-2) MECHANICAL EFFECTS BEYOND THE CLOSE-IN ZONE OF AN UNDERGROUND NUCLEAR EXPLOSION IN GRANITE. Michaud, L. Translated for Univ. of California Lawrence Livermore Lab., from report IAEA-PL-388/8. 14p. Dep. NTIS.

During French nuclear experiments in a granite massif at Hoggar, the movements of the medium were recorded by mechanical detectors measuring displacements, velocities and accelerations. The results are fairly well grouped and the principles established experimentally for the widely differing explosion energies and distances from ground zero agree well with similarity relationships having the following form: movement = $K(W^{\frac{1}{3}}/R)^n$, with a dispersion not exceeding 50%. In addition, a number of observations were made on structures and materials exposed to such movements. Several hundred photographs were taken before and after the explosions in horizontal galleries oriented toward ground zero and also on the surface of the massif. The results make it possible to calculate limiting distances for damage for each type of material and mode of attachment. For example, for a perpendicular wall of light concrete blocks, the limiting distance for moderate damage (very obvious cracks) is found to be 700 $m/kt^{\frac{1}{3}}$. A study correlating ground movements and the extent of the damage shows the displacement velocity of ground movement at the point of interest to be the most reliable criterion of the observed effect. For the above example, the radial displacement velocity is 18 cm/sec. Further data have been collected on various kinds of materials, metal containers, electronic equipment, electric motors, etc. The results enable us to predict the probable damage from a nuclear explosion and to make recommendations to minimize such damage. (auth)

53130 (UCRL-Trans-10616-4) EFFECTS OF AN UNDERGROUND NUCLEAR EXPLOSION ON THE SURROUNDING ROCK. CONTENT OF THE CAVITY AND CHIMNEY, AND OF THE ZONES OF CRUSHING AND FRACTURING. Derlich, S. Translated for Univ. of California Lawrence Livermore Lab., from report IAEA-PL-388-10. 24p. Dep. NTIS.

French nuclear experiments in a granite massif have produced cavities and associated chimneys due to rock collapse. The cavities are surrounded by concentric zones of crushed and fractured rock. Transformations of the rock medium have been studied by means of boreholes which pass near the detonation point or are drilled to various parts of the cavity or chimney. The lower half of the cavity is roughly hemispherical. The chimney geometry is affected by the geologic nature of the rock medium and by the extent to which it is already fractured. The shape of the cavity-chimney complex resembles an ellipsoid of revolution whose major axis is 4.5 times, and the minor axis 2.8 times, the cavity radius. The contents consist of debris and resolidified molten rock. The crushed zone consists of coherent rock of chalk-like appearance with porosity of 14% and permeability of the order of 10 millidarcy, and the fractured zone of fragmented rock of increasing size as one moves away from the detonation point. The relationship between the explosion yield W (in kilotons) and the cavity radius R (in meters) is in good agreement with the theoretical laws based on physical phenomena. The relationship does not always correspond to the formulas proposed elsewhere for other rock media, or even for granite. The differences can be explained in terms of parameters such as the pressure of vaporized products, constants derived from the equations of state, the dimensions of the explosive chamber, and the rock stresses. (auth)

53131 (UCRL-Trans-10616-5) MECHANICAL EFFECTS IN THE CLOSE-IN ZONE OF AN UNDERGROUND NUCLEAR EXPLOSION IN GRANITE. Michaud, L.; Maury, J. Translated for Univ. of California Lawrence Livermore Lab., from report IAEA-PL-388/11. 16p. Dep. NTIS.

During the French underground nuclear tests at Hoggar a large number of measurements and observations were carried out in the close-in zone, to determine in particular the time of arrival of the shock wave and the characteristics of the cavity formed by the explosion. Calculation programs were developed in order to predict and interpret the various results. Code S in particular, is a Lagrangian one-dimensional program giving a numerical stimulation of the shock wave propagation. In addition to the calculation of the shock parameters, it provides a means of evaluating the following effects: vaporization and melting due to shock, crushing and brittle or plastic rupture of the material, opening and closing of radial and tangential fractures, elastoplastic and elastic deformations of a solid, and the initial profile of the energy liberated by the shock in the form of heat. Applied to the case of granite, code S supplemented by the adiabatic elasticity and the characteristic quantities of the medium as determined in the laboratory enabled us to describe all the characteristic phenomena in the close-in zone. Calculated and experimental arrival times of the shock wave were compared, and good agreement was obtained up to pressures of several megabars. Detectors located up to a few decimeters from the wall enabled us to follow the evolution of the shock wave during the first few microseconds of its travel. Calculations also show that the dimensions of the final cavity are a function not only of the explosion yield and the local lithostatic pressure but also of shear strength of the rock and the dimensions of the explosion chamber. (auth)

53132 (UCRL-Trans-10617-2) RADIOLOGICAL RISKS RELATIVE TO THE DISTRIBUTION OF CONTAMINATED GAS. Combet, M.; Gerard, R. Translated for Univ. of California Lawrence Livermore Lab., from report 103/SPS. 15p. Dep. NTIS.

The average and maximum radiation doses likely to reach consumers who, for all their usual requirements, use natural gas that has been stored in a cavity created by a nuclear explosion are given. The incidences of contamination with ^{85}K and tritium for gas used commercially, industrially, and in agriculture were studied in detail. The results indicate that the doses involved are 5000 times less than the limits admissible for the population. (T.D.)

53133 (USGS-474-155) EXPLOSION-INDUCED FRACTURES OF SELECTED ANNOUNCED UNDERGROUND NUCLEAR TESTS, YUCCA FLAT, NEVADA TEST SITE, NEVADA, JANUARY 1971-DECEMBER 1971. Steele, Susan G.; Snyder, R. P. (Geological Survey, Denver, Colo.). Aug 1972. 31p. (NTS-237). Dep. NTIS.

During 1971, personnel of the U.S. Geological Survey mapped the surface effects produced by eight announced underground nuclear tests conducted in Areas 2, 3, and 9 in Yucca Flat, Nevada Test Site. Faults on which previous explosion-induced movement had been noted were reactivated by some tests. Some tests produced neither surface fractures nor collapse features. (auth)

53134 BACKGROUND INFORMATION FOR THE DEVELOPMENT OF A RADIATION STANDARD FOR TRITIUM IN NUCLEAR-STIMULATED NATURAL GAS. Moghissi, A. A.; Patzer, R. G.; McNelis, D. N.; Carter, M. W. (Western Environmental Research, Lab., Las Vegas, Nev.). pp 228-35 of Radiation Protection Standards: Quo Vadis. Vol. I. Howell, Wallace P. (ed.). Richland, Wash.; Health Physics Society (1972).

From 6th annual topical symposium on radiation protection standards: quo vadis; Richland, Wash. (2 Nov 1971).

The development of a radiation standard for tritium in natural gas requires the knowledge of the relationship between the tritium concentration in the gas and the annual dose received by the people resulting from the usage of the gas. Although this relationship can be calculated, the uncertainties associated with the input parameters are so large that the results could have a range of 10^3 or higher. Consequently, laboratory experiments were carried out to better estimate this ratio. In the first set of experiments, the transfer of tritium from natural gas into food cooked under realistic conditions was determined. In a second set of experiments, the contribution of heating with tritiated gas in an area with limited ventilation, to the tritium body burden was experimentally deter-

mined. Under the selected experimental condition it was found that a natural gas concentration of 1 nCi/l (STP) would result in tritium concentration in body water of 14 nCi/l. (auth)

Protective Structures and Equipment

53135 (ORNL-TM-3485(Vol.1)) ACTIVE AND PASSIVE DEFENSE INTERACTION STUDIES. VOLUME I. SUMMARY, MODELS, AND CALCULATIONS. Haaland, Carsten M.; Wigner, Eugene P.; Wilson, John V. (Oak Ridge National Lab., Tenn.). Dec 1971. 232p. Dep. NTIS.

The shortness of the time of flight of submarine launched missiles renders both quick access to shelters and delay of the attack by missile defense important. In order to evaluate the relative effectiveness of the two types of protection—quick access shelters and missile defense—three models were investigated. The first of these is concerned with individual cities or territories (called "islands") which are within the range of a single missile defense installation. The second and third models are concerned with the interaction of the defenses of the islands of the entire nation. The second one assumes, as does the first, that the attacker knows whether or not his missile reached its target before committing a second missile to the same target. This "shoot-look-shoot" assumption is surely not valid if the defense adopts a probabilistic tactic whereby some targets are defended and others are not and if reasonable civil defense is available so that the vulnerability of people decreases as a result of the movement to shelter. Hence, the last model considered discards the shoot-look-shoot assumption and deals in particular with the idea of the probabilistic defense. However, the study is not complete in this regard. Calculations are made for the first two models with parametric attack levels and defense budgets, with three types of shelter postures, including shelters obtained by slanting techniques in new construction towards blast resistance, and also special-purpose shelters. Costs of current safeguard components are assumed for active defense and no leakage is assumed. The results show that combinations of ABM and shelters are usually more effective in reducing fatalities than either ABM or shelters alone. (auth)

53136 RADIATION PROTECTION SHIELDING. Bonet-Maury, Paul; Audouin, Maurice. French Patent 2,070,548. 10 Sep 1971. Filed 9 Dec 1969. (In French).

This inexpensive radiation protection shielding consists of an assembly of juxtaposed railway lines, the longitudinal axes being parallel. The spaces between the rails are filled with a dense material, e.g., ferrous-type material. The cores of the rails are mutually parallel and perpendicular to the plane of the assembly. The rails are arranged so that the heads of adjacent rails interlock with the cores of intermediate adjacent rails. (France)

Safety Engineering

Refer also to abstract 55445.

53137 (JAB-99-96) INVESTIGATION OF GROUND MOTION-DAMAGE RELATIONSHIPS FOR RESIDENTIAL BUILDINGS IN GLENDALE, CALIFORNIA: SAN FERNANDO EARTHQUAKE, FEBRUARY 1971. Farhoomand, I.; Scholl, R. E. (Blume (John A.) and Associates Research Div., San Francisco, Calif.). Aug 1972. Contract AT(26-1)-99. 35p. Dep. NTIS.

The investigation of the relationship between the observed damage to the residential buildings in two selected control areas within Glendale, California, and the ground motion resulting from the San Fernando earthquake is presented. The procedures used in performing the structure inventory and the damage survey are described. The ground motion characterization, structure idealization, and damage description used to derive the ground motion-damage relationships are also given. Results of the investigation are ground motion-damage relationships for overall building damage as well as for building components. One of the more significant conclusions is that interior walls and chimneys are more susceptible to damage than other building components. (auth)

Vacuum Engineering

Refer also to abstracts 53318 and 54085.

53138 INTERNATIONAL COLLOQUIUM ON THE APPLICATION OF VACUUM TECHNIQUES TO THE SEMICONDUCTOR INDUSTRY, ELECTRONIC, AND MICROELECTRONIC COMPONENTS. AVISEM 71. Conference Held at Versailles, France, September 13, 1971. Paris; Societe Francaise des Ingenieurs et Techniciens du Vide (1971). 467p. (In French and English). (CONF-710932).

Of sixty-six papers presented, a separate abstract was prepared for four. An abstract of one paper previously appeared in NSA as 26: 4213. (TSS)

For abstracts of individual papers see: 52902, 52937, 53139, and 54976.

53139 DEVELOPMENT OF A ULTRAHIGH VACUUM EVAPORATION UNIT USING A LIQUID He CRYOPUMP WITH A HIGH PUMPING SPEED. Thibault, J. J. (L'Air Liquide, Sassenage, France); Boissin, J. C.; Richardt, A. pp 40-7 of International Colloquium on the Application of Vacuum Techniques to the Semiconductor Industry, Electronic, and Microelectronic Components. Paris; Societe Francaise des Ingenieurs et Techniciens du Vide (1971). (In French).

From third international symposium on the application of vacuum techniques in semiconductor industry, electronic components, and microelectronics; Versailles, France (13 Sep 1971). See CONF-710932.

A unit is presented for the in-vacuo deposition of thin films. It has the following characteristics: rapid operation; an uncontaminated ultrahigh vacuum (5×10^{-9} torr); a high pumping rate ensuring a small pressure rise during evaporation (1.5×10^{-8} torr for a Nb deposit). (France)

53140 VAKUUMTECHNIK. GRUNDLAGEN UND ANWENDUNGEN. (Vacuum Techniques. Principles and Applications). Pupp, Wolfgang. Thiemig-Taschenbuecher, Band 43. Munich; Verlag Karl Thiemig (1972). 4011p. DM 28,-.

The fundamentals of vacuum techniques including vacuum physics, measurement of vacuum, and use of the mass spectrometer as a device for measuring partial pressure and transport of gases are presented. Special emphasis is placed on ultrahigh vacuum technology. Also discussed are the design and operation of vacuum installations, advantages and disadvantages of various structural materials, criteria for the spatial arrangement and coordination of pumps and monitoring devices, and the control and safety aspects in automated facilities. Amplifiers, television tubes, photomultipliers, x-ray tubes, and electron microscopes for special applications such as in nuclear physics installations and space simulation are discussed. With respect to industrial applications, the drying of chemical products is discussed as well as freeze drying, impregnation of electrical cables, distillation, high vacuum metallurgy, and the production of thin layers through cathode evaporation. (H.B.G.)

53141 IMPROVEMENTS TO ION PUMPS. (to Societe RIBER, SA). French Patent 2,097,288. 3 Mar 1972. Filed 1 Jul 1970. (In French).

An ion pump is described which consists of at least one cathode and anode inside a casing. The cathode is retained by a sliding device. The removal of the cathode from this casing (or its introduction) is effected by sliding it in this device. This pump enables pressures of less than 10^{-12} torr to be obtained. (France)

ENVIRONMENTAL AND EARTH SCIENCES

Minerals and Ores

53142 (AREAEE–138) MINERALOGY AND SOME TRACE ELEMENTS GEOCHEMISTRY OF SAMPLES FROM SOUTHWEST ASWAN RADIOACTIVE SYENITE ROCK WESTERN DESERT. Sayyah, T. A.; Mahdy, M. A. (Atomic Energy Establishment, Cairo (Egypt). Geology and Raw Materials Dept.). 1972. 22p. Dep. NTIS (U. S. Sales Only).

Mineralogical, as well as some trace elements geochemical studies, were carried out on some samples from southwest Aswan radioactive syenite rock. The presence of thorite–thorogummite radioactive mineral suite as well as the rare earth mineral bastnaesite were reported for the first time in this radioactive syenite rock occurrence. Zircon, rutile and its polymorph brookite, anatase, and the Nb-rich variety are present as heavy accessory minerals. Geochemically, these rocks are characterized by high Th, Zr, Nb, Y, and Ti contents. The iron is present mainly in an oxidized state which may be due to hydrothermal alteration that might accompany the radioactive mineralization. (auth)

53143 (GJO–936–1) GEOLOGY AND ALTERATION ASSOCIATED WITH WYOMING URANIUM DEPOSITS. Files, Frederic Grant (California Univ., Berkeley). 1972. 132p. Dep. NTIS.

Thesis.

Results are reported of a study aimed at establishing the physical and chemical factors responsible for roll formation and migration of uranium ore bodies at the Crooks Gap, Gas Hills, and Shirley Basin deposits in Wyoming. (D.H.M.)

53144 (GJO–936–2) TREND OREBODIES OF THE SECTION 27 MINE, AMBROSIA LAKE URANIUM DISTRICT, NEW MEXICO. Kendall, Ernest Whitney (California Univ., Berkeley). 1972. 178p. Dep. NTIS.

Thesis.

The sandstone-uranium deposits at the southern edge of the San Juan Basin near Grants, New Mex. were studied. The work concentrated on the trend ore in an attempt to better understand the physical and chemical conditions responsible for ore formation. The trend ore consists of flattened, elongated, ellipsoidal masses of Westwater Canyon sandstone whose pore space has been filled with ore phases. The individual ore pods are roughly concordant with bedding and are clustered in narrow belts called ore trends. The ore consists principally of pyrite, calcite, and a submicroscopic mixture of humic material and the uranium silicate, coffinite. Vanadium and selenium phases and jordisite were also found. It is concluded that the trend ore was probably formed by slowly moving ground water in early Cretaceous time, and that the ore bodies represent a slowly migrating reaction zone in which phases are destroyed by oxidation and dissolution at the southern edge and reprecipitated at the northern edge of the ore trend. (L.C.L.)

53145 STRUCTURAL STUDIES ON THE URANIUM DEPOSIT OF THE FAY MINE, ELDORADO, NORTHWEST SASKATCHEWAN. Morton, R. D.; Sassano, G. P. (Univ. of Alberta, Edmonton). Can. J. Earth Sci.; 9: No. 7, 803-23(Jul 1972).

The Fay Mine uranium deposit is composed of veins parallel to the foliation of the paragneisses and paraschists of the Fay Mine Complex, which in turn overlies the Donaldson Lake Gneiss and Foot Bay Gneiss, within the Tazin Group of the Beaverlodge District, northern Saskatchewan. A computer oriented study of 5500 strike-dip measurements of planar features within the Fay Mine reveals that the lowest member of the metamorphic sequence, the Foot Bay Gneiss, is unique in that it exhibits Kenoran (?) structures associated with F1, NW-SE or N-S trending folds. Subsequent to the Kenoran (?) folding, an Aphebian (?) sequence of sediments and volcanics, now represented by the Donaldson Lake Gneiss and the Fay Mine Complex, was deposited. NE-SW trending, Hudsonian, F2 folds then developed and extensive cataclasis was effected. The F2 structures also affected the uppermost, taphrogeosynclinal Martin Formation sediments and volcanics. The major faults of the district are thought to have been initiated either as F2-shear joints or F2-tension fractures and have undergone multiple movement over a long period of time. The pitchblende ± quartz ± carbonates ± hematite ± chlorite veins, classified as "mobilized stratabound deposits", occur parallel to S2 foliation planes in the crests, troughs, or limbs of F2 folds, wherever minimal plunge is observed. Such deposits may have been generated during regional metamorphism by mobilization of uranium-rich fractions from the originally uraniferous Aphebian precursors of the Fay Mine Complex. Later movement of such major structures as the St. Louis Fault has apparently caused only local deformation and brecciation of the uraniferous veins and has caused no more than limited recrystallization. (auth) (Canada)

53146 URANIUM CONTENT OF THE UPPER JURASSIC BLACK BITUMINOUS ARGILLITES OF THE WEST SIBERIAN PLATE. Pluman, I. I. (Novosibirsk Geological Bureau, USSR). Geochem. Int. (Engl. Transl.); 8: No. 6, 845-51(1971).

Translated from Geokhimiya; No. 11, 1362-8(1971).

The upper Jurassic black bituminous argillites of the West Siberian plate are regionally enriched in uranium (up to 70 ppM U). The argillites have high organic carbon content (up to 10% and more) and are also enriched in molybdenum, vanadium, and zinc. (auth)

53147 URANIUM AND THORIUM IN THE ALKALI OLIVINE BASALT SERIES. Gladkikh, V. S.; Lebedev-Zinov'yev, A. A. (Inst. of Mineralogy, Geochemistry, and Crystal Chemistry of Rare Elements, Moscow). Geochem. Int. (Engl. Transl.); 8: No. 6, 813-20(1971).

Translated from Geokhimiya; No. 11, 1315-23(1971).

Distribution of uranium and thorium has been determined in 158 samples of lavas belonging to the alkali olivine basalt series (of the Maymecha–Kotuy and Kuznetsk–Alatau provinces and the graben zone of the southern part of the Russian platform). The concentrations of the radioactive elements in the lavas of the same petrochemical type are similar. The highest uranium and thorium concentrations are found in the differentiates of the alkali olivine basalt magma with the highest sodium and potassium contents. (auth)

53148 CONQUISTA MINES WIDE-RANGING SOUTH TEXAS URANIUM DEPOSITS. Eng. Mining J.; 173: No. 8, 74-7(Aug 1972).

The equipment and methods used to find, mine, and process uranium ore from deposits near Falls City, Tex. are described. The Conquista Project, which includes these activities is designed to produce 1.5 M lb/y of U_3O_8. The program for monitoring liquid and solid wastes from the extraction plant operations is mentioned. (L.C.L.)

Radioactive Effluents

Refer also to abstracts 53192, 55220, 55285, 55293, 55301, 55331, 55337, and 55338.

53149 (RLO–2227–T–12–26) ^{65}Zn SPECIFIC ACTIVITIES FROM OREGON AND WASHINGTON (U.S.A.) CONTINENTAL SHELF SEDIMENTS AND BENTHIC INVERTEBRATE FAUNA. Carey, A. G. Jr.; Cutshall, N. (Oregon State Univ., Corvallis (USA). School of Oceanography). 1972. Contract AT(45-1)-2227. 16p. Dep. NTIS.

The relationships between the benthic fauna and sediments on the continental shelf of Oregon and Washington were investigated by determining specific activities of ^{65}Zn, a radionuclide present in the Northeast Pacific Ocean. Zinc-65, induced by neutron activation in Columbia River water used to cool plutonium production reactors at Richland, Washington, was carried down the river and into the marine environment. Sediment from the Columbia River moves northward. Zinc-65 specific activities in sediment and benthic invertebrates decrease northward with distance from the river and westward with both distance and depth. Many organisms to the south of the river mouth and westward with depth have higher ^{65}Zn specific activities than the sediments in, or on, which they live. Other sources of ^{65}Zn via the food web are suspected as the cause for the differential in specific activity between the sediment and benthic fauna. Long-term declines in ^{65}Zn specific activities were noted. A wide range of ecological and systematic forms are included. (auth)

Radioactivity Transport and Monitoring

Refer also to abstract 53459.

53150 (ANL–7860(Pt.3)) RADIOLOGICAL PHYSICS DIVISION ANNUAL REPORT. Environmental Research, January–December 1971. Rowland, R. E.; Gustafson, P. F. (Argonne National Lab., Ill.). [nd]. Contract W-31-109-eng-38. 320p. Dep. NTIS.

Major divisions included are: terrestrial ecology, aquatic ecology, bioenvironmental studies, and atmospheric physics. Separate abstracts were prepared for fifteen of the thirty-seven sections. (D.H.M.)

For abstracts of individual sections see: 52914, 53151, 53152, 53162–53164, 53169, and 53182–53189.

53151 (ANL-7860(Pt.3), pp 46-50) TRITIATED WATER RECOVERY SYSTEM. Stewart, M. L.; Kline, J. R.; Jordan, C. F. [nd].

In Radiological Physics Division annual report, January-December 1971.

Equipment used in extracting and collecting tritiated water is described. The technique is based on well-known freeze-drying methods. The primary features of this system are: simplicity of the glassware, ease of operation, the large number of samples which can be processed simultaneously, range of sample sizes, and cost of the equipment. (auth)

53152 (ANL-7860(Pt.3), pp 230-49) PLUME RISE DETERMINATION BY THE TABULATION PREDICTION TECHNIQUE. Moses, Harry; Kraimer, Martin R. [nd].

In Radiological Physics Division annual report, January-December 1971.

Six hundred and fifteen plume rise measurements from 26 different stacks obtained during 10 research programs conducted in 5 different countries have been collected and used to construct the Tabulation Prediction Technique tables for determining plume rise. This technique is rather easy to use, but both statistical and meteorological skills are required to construct the prediction tables. Since results obtained appear to be as good or superior to those obtained with any of the formulas appearing in the literature, the operational simplicity of the present method recommends its use for routine plume rise estimates required in engineering problems. (auth)

53153 (DPSPU-72-30-1) ENVIRONMENTAL MONITORING IN THE VICINITY OF THE SAVANNAH RIVER PLANT. Annual Report, 1971. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Plant). 1972. 21p. Dep. NTIS.

A continuous monitoring program has been maintained since 1951 (before plant startup) to determine the concentrations of radioactive materials in a 1200-square mile area outside the Savannah River Plant. Included are parts of Aiken, Barnwell, and Allendale counties in South Carolina; and Richmond, Burke, and Screven counties in Georgia. Although very small amounts of gaseous and liquid radioactive materials are discharged to the environment, environmental levels continue to be far below levels considered significant from a public health viewpoint. The quantity of radioactivity released by SRP to its environs during 1971 is, for the most part, too small to be distinguished from natural background radiation and fallout from worldwide nuclear weapons tests. Particulate beta activity detectable in air is due entirely to global fallout. This concentration in air at the plant perimeter and 25 miles away represents 0.2% of the Concentration Guide (defined in the Applicable Standards section which follows). Tritium oxide in air at the plant perimeter is greater than in air at more distant locations. The average concentration at the plant perimeter, only 0.1% of the Concentration Guide, is the largest percentage of any air Concentration Guide for plant-released radionuclides. Tritium, cesium-137, strontium-89, and strontium-90 are the only radionuclides of plant origin detectable in river water. None of these had an average concentration that exceeded 0.2% of the Concentration Guide in river water sampled 8 miles downstream from the plant. Radioactive materials in river fish also continue to be very low. Various water-quality analyses of river water samples surveyed by SRP indicate that Savannah River water is not adversely affected by SRP operations. This is substantiated by surveys of the health of the Savannah River biota by the Academy of Natural Sciences of Philadelphia (Appendix C). (auth)

53154 (INIS-mf-160, pp 22-52) MICROMETEOROLOGICAL STUDIES FOR AIR POLLUTION CONTROL IN ATOMIC ENERGY. Shirvaikar, V. V. (Bhabha Atomic Research Centre, Bombay (India)). 1971. (CONF-700847-5). INIS.

From Seminar on pollution and human environment; New Delhi, India (26 Aug 1970).

The measures adopted for control and prevention of air pollution, during the design stage of reactors and power plants in India, are outlined. The safety philosophy was adopted to ensure that under normal operating conditions, the maximum dose to any individual member of the public does not exceed 500 mr/year and that under accident conditions the dose is below 25 r. These values are well below the limits prescribed by ICRP for safety limits. Micro-meteorological studies have been carried out at the four nuclear power plant sites, viz., Trombay, Tarapur, Rajasthan, and Kalpakkam, with the aim of studying the diffusion potential of atmosphere at different seasons of the year and also to determine the worst meteorological conditions obtainable at a site. Specific devices used for proper strategy to be applied for studies at such sites, which are uneven and near large water bodies, have been described. Smoke photography technique has been used for diffusion studies. The data collected have been used for determining the height of stacks and for calculating the required containment factors for various exclusion distances for power reactors. (auth) (INIS)

53155 (MLM-1946) BIBLIOGRAPHY ON HANDLING, CONTROL, AND MONITORING OF TRITIUM (DECEMBER 1968-JANUARY 1972). Hannahs, B. J.; Kershner, C. J. (Mound Lab., Miamisburg, Ohio). 5 Sep 1972. Contract AT(33-1)-Gen-53. 44p. Dep. NTIS.

This annotated bibliography was prepared for the purpose of providing a collected source of information on recent literature available on subjects relating to the control, monitoring, and handling of tritium. Particular emphasis was placed on literature that relates to the tritium handling and control needs of the Division of Military Applications/United States Atomic Energy Commission. The period covered in the preparation of this bibliography was from 1968 to January 31, 1972, and includes both journal and report literature. Keyword and author indexes are provided for general applicability of this document and a subject grouping format was followed in arranging the references so as to increase its utility for those interested in tritium effluent control and waste management. (auth)

53156 (SZS-128) RESULTS OF FALLOUT MONITORING IN THE GERMAN DEMOCRATIC REPUBLIC 1970. Kunert, J.; Schulze-Wollgast, U.; Zindler, H.; Gegusch, H. (Staatliche Zentrale fuer Strahlenschutz, Berlin (East Germany)). Feb 1972. 47p. (In German). Dep. NTIS (U. S. Sales Only).

The results of monitoring of air, precipitation, fallout, water, soil, plants and foodstuffs are presented. The gross beta activity deposited on the territory of the GDR was higher than in the preceding year. This increase was caused by the influx of fresh fission products. However, an increase of the cumulative amount of ^{90}Sr and ^{137}Cs in fallout could not be detected unequivocally. In most of the other environmental samples surveyed no changes could be observed in comparison to 1969, with the exception of plants which showed an increase of excessive beta activity, ^{90}Sr and ^{137}Cs as a result of the higher deposition on the soil surface during the corresponding growing seasons. (auth)

53157 RADIATION AND HEALTH. McLean, A. S.; Morley, F.; Peirson, D. H.; (and others). London: Royal Society for the Promotion of Health (1971). 80p.

The subject is dealt with under the following sections: atomic energy—benefits and precautions (1. the public attitude, 2. maximum permissible levels, 3. the role of the public health authority); radiation levels in relation to nuclear power (1. nuclear power and radioactive wastes, 2. waste management objectives, 3. disposal methods, 4. legal controls); radiation levels—air (1. natural radioactivity, 2. artificial radioactivity, 3. radiological hazard); radiation in water I (1. natural alpha-activity, 2. artificial alpha-activity, 3. natural beta-activity, 4. artificial beta-activity, 5. contribution of activity by water); radiation in water II (1. natural radioactivity, 2. surveillance of sources, 3. levels of radioactivity in drinking water, 4. fallout); significance of dietary contamination with radioactive substances (1. radioactivity in foodstuffs, 2. the critical nuclides, 3. relative significance of the critical nuclides in different circumstances). (UK)

Atmosphere

Refer also to abstracts 53227 and 53511.

53158 (FOA-4-4502-A-1) INVESTIGATION OF AIRBORNE RADIOACTIVE MATERIAL ORIGINATING FROM AN UNDERGROUND NUCLEAR EXPLOSION IN USSR THE 23 OF MARCH 1971. Eriksen, Bjoern (Forsvarets Forskningsanstalt, Stockholm (Sweden)). Jul 1972. 18p. (In Swedish). Dep. NTIS (U. S. Sales Only).

Short-lived radioactive substances, primarily ^{140}Ba were discovered in samples from ground-level air in different parts of Sweden during the latter part of March and early May 1971. The activity composition and cloud calculations in combination with seismological observations indicated that the most probable explanation to this radioactivity was a leakage from an underground nuclear explosion west of the Ural mountains on the 23rd of March 1971. The results of gamma-spectrometric measurements performed on samples of ground-level air during the period, as well as calculations of the amount and composition of the extra radioactivity are described. (Sweden)

53159 (UUIM-26) NATURAL β-ACTIVITY IN THE AIR NEAR THE GROUND. Parts B-E. Israelsson, S.; Knudsen, E.; Ungethuem, E. (Uppsala Univ. (Sweden). Inst. of Meteorology). 1972. 46p. Dep. NTIS (U. S. Sales Only).

Studies were made on the natural β-activity in the air near the ground at Marsta Observatory (59°55′ N, 17°35′ E Gr). Four separate parts (B-E) are included. In part B the influence of wind

upon the natural β-activity is discussed. Part C deals with the influence of the precipitation upon the natural β-activity. In part D the vertical distribution of the natural β-activity is described. In Part E analysis of the natural β-activity variations with time is made. (auth) (Sweden)

53160 (UUIM-27) NATURAL α-ACTIVITY IN THE AIR NEAR THE GROUND. Israelsson, S.; Knudsen, E.; Ungethuem, E. (Uppsala Univ. (Sweden). Inst. of Meteorology). 1972. 34p. Dep. NTIS (U. S. Sales Only).

The results of part of a program for investigating the radioactivity in the air near the ground and its connection with atmospheric electricity are reported. Studies have been made of the meteorological influence upon the natural α-activity concentration in the air near the ground. The method of measuring α-activity concentration is presented along with a few preliminary results from measurements made in the summer of 1970. The variation with time of the natural α-activity concentration was also studied. (auth)

53161 RADIOACTIVE FALLOUT IN NORWAY. Hvinden, T. (Forsvarets Forskningsinstitutt, Kjeller, Norway). Sivilt Beredskap; 14: No. 3, 24-6(1971). (In Norwegian).

Radioactive fallout in the period 1956 to 1970 in Norway was analyzed. A series of diagrams show the concentration in air and precipitation at Kjeller (near Oslo) as a function of time, the geographic distribution of fallout and of ^{131}I, ^{137}Cs, and ^{90}Sr in milk from 10 places in Norway averaged over the whole period, and ^{137}Cs concentrations in the meat from sheep, cattle and reindeer as a function of time. The text comments and explains these diagrams. The State Council for Radiation Hygiene has published estimates of the radiation effects on the population as a result of radioactive fallout concluding that while fallout can have caused some cases of cancer, leukemia and genetic damage, the estimated number of cases is less than 5 percent of the naturally occurring cases and cannot be statistically corroborated. (Norway)

Soil

53162 (ANL-7860(Pt.3), pp 1-13) DISTRIBUTION OF ^{137}Cs IN SOILS AND VEGETATION ON THE ISLAND OF PUERTO RICO. Kline, J. R.; Colon, J. A.; Brar, S. S. [nd].

In Radiological Physics Division annual report, January–December 1971.

Soils and vegetation of Puerto Rico were collected along five north-south transects of the island and analyzed for ^{137}Cs content. The results showed an apparent gradient of this nuclide with high amounts in the eastern samples and low amounts in the western samples. Activity in samples was strongly related to rainfall patterns on the island; however, high mountain forests were much more highly contaminated than could be accounted for on the basis of rainfall deposition alone. This was attributed to the properties of vegetation itself, rather than alteration of deposition patterns. The vegetation is suggested to have high aerosol interception efficiency and low turnover rates, which could combine to produce the observed concentrations. Data from soil samples suggest that the island has intercepted a minimum of 535 curies of ^{137}Cs from past nuclear weapons tests. (auth)

53163 (ANL-7860(Pt.3), pp 32-7) INDEPENDENT TEST OF THE ARGONNE MODEL FOR TRITIUM MOVEMENT IN SOIL. Jordan, C. F.; Stewart, M. L.; Kline, J. R. [nd].

In Radiological Physics Division annual report, January–December 1971.

An independent test of the Argonne model for tritium movement in soil was carried out during the summer of 1971. There was good agreement between the predicted and observed downward movement of the tritium peak, the predicted and observed peak broadening, and the predicted and observed peak immobilization. Observed and predicted concentrations of tritium (HTO) differed by about one percent of the tritium (HTO) entering the soil per unit surface area. This difference probably is caused by tritium exchange with clay-bound hydroxyl groups. (auth)

Water

Refer also to abstract 53535.

53164 (ANL-7860(Pt.3), pp 64-76) STUDIES OF RECENT SEDIMENTATION IN GREEN BAY. Edgington, D. N.; Thommes, M. M.; Callender, E. [nd].

In Radiological Physics Division annual report, January–December 1971.

Results are reported of the determination of trace elements in sediments and core samples from the Green Bay. Data on the distribution of U, Th, Zn, Fe, La, Co, Cd, Cu, As, and Hg with depth in cores from Green Bay are given. (D.H.M.)

53165 (RLO-2225-T-25-6) COLUMBIA RIVER EFFECTS IN THE NORTHEAST PACIFIC: PHYSICAL STUDIES. Progress Report, June 1971–June 1972. Barnes, Clifford A.; Smith, J. Dungan (comps.) (Washington Univ., Seattle. Dept. of Oceanography). 20 Jul 1972. Contract AT(45-1)-2225, TA 25. 12p. Dep. NTIS.

During the past year efforts continued in the physical oceanography studies started in 1961 for determining the properties, distributions and movements of Columbia River water and its transported materials in the northeast Pacific Ocean. Based on the general background circulation as established in earlier studies the work stressed making, in detail, direct current measurements using vertical arrays of 6 or 7 meters each at two locations concurrently on the Washington shelf, one some 20 km off the coast at 77 m, and the other 50 km off near the shelf edge at 130 to 160 m. Despite an increased and improved stock of current meters and supporting equipment and techniques the desired continuous recordings of currents at the two type locations throughout the year are still lacking. To avoid breaks in continuity this would require double sets of equipment for each location, one to be deployed as the other was retrieved. A third array is needed to establish and interpret the horizontal field. A quite coherent picture of the current structure in the vertical was found but the variations laterally are so complex that details of this picture will evolve slowly. Knowledge of the general area mass and current structure at selected periods has been strengthened northward to the Strait of Juan de Fuca and seaward of the Washington shelf. Analysis of the observations made the past year, still continuing, and further analysis made of previous information both substantiate and add needed detail to the picture of coastal circulation and sediment transport that was developed earlier. Work in the immediate future as in the past year should continue to emphasize the circulation on the Washington shelf on a relatively fine scale in both space and time, relate the variations to the forcing functions and establish such local anomalies as may occur from the Columbia River mouth north to the Strait of Juan de Fuca. (auth)

53166 (RLO-2227-T-12-28) EFFECTS OF OCEAN WATER ON THE SOLUBLE-SUSPENDED DISTRIBUTION OF COLUMBIA RIVER RADIONUCLIDES. Evans, D. W.; Cutshall, N. H. (Oregon State Univ., Corvallis (USA). School of Oceanography). [nd]. Contract AT(45-1)-2227. 30p. Dep. NTIS.

The relationship of dissolved concentrations of Hanford radionuclides with salinity in the Columbia River estuary was interpreted in terms of the exchange of the radionuclides between dissolved and suspended particulate phases. Both ^{65}Zn and ^{54}Mn carried by the Columbia River were partially desorbed from suspended particulate matter upon mixing with ocean water in the estuary. Experiments in which ocean water was added to Columbia River water and to suspended particulate matter collected on filters confirmed the partial desorption of ^{65}Zn and ^{54}Mn from the particulate phase. The percentage of ^{65}Zn and ^{54}Mn desorbed varied with experimental approach but desorption of ^{65}Zn seemed to lie in the range 15 to 45% and ^{54}Mn in the range 30 to 60%. None of the experiments revealed any effect of salinity upon the soluble-suspended particle distribution of ^{51}Cr, ^{124}Sb, or ^{46}Sc. Dissolved concentrations of these nuclides varied inversely with salinity. There was no evidence that any of the radionuclides studied were removed from solution by flocculation, precipitation, or adsorption as a result of mixing with ocean water. Ocean water contact partially removed ^{54}Mn but not ^{65}Zn, ^{46}Sc, or ^{60}Co from Columbia River bottom sediments transferred to the marine environment. The inability of ocean water to desorb ^{65}Zn from bottom sediment contrasts with its action with suspended particulate ^{65}Zn. (auth)

53167 RADIOISOTOPE PARTITION BETWEEN SEA WATER AND SEDIMENTS. Kuznetsov, Yu. V.; Shchebetkovskii, V. N. Geochem. Int. (Engl. Transl.); 8: No. 6, 891-6(1971).

Translated from Geokhimiya; No. 12, 1466-72(1971).

Determinations of the absorption of ^{137}Cs, ^{144}Ce, and ^{234}Th by deep-water red clay and for iceberg, foraminiferal, and diatom oozes are reported. Geochemical concepts are used to explain the sorption series. It is shown that the isotopes are distributed in different ways. (auth)

53168 ISOTOPE HYDROLOGY IN LATIN AMERICA. Payne, Bryan R. Int. At. Energy Agency Bull.; 14: No. 3, 17-20(1972).

Current uses of radioisotopes in hydrological research in Latin America are discussed. The most common uses are in studies of sediment transport and pollution and in projects for the development of groundwater in arid areas. Radioisotope tracer studies of sediment transport have been used in connection with the maintenance of navigable channels and harbors, location of cooling water intakes and sewage outlets, and the location of sand dredging sites for building purposes. Ground water tracer studies have been used to define the source, location, and flow of water supplies in all the Latin American countries where water supply problems are acute. (L.C.L.)

Ecosystems and Food Cycles

Refer also to abstracts 53134, 53506, 53520, 53522, 53527, 53530, 53532, and 53539.

53169 (ANL–7860(Pt.3), pp 141–50) RADIONUCLIDES IN LAKE MICHIGAN FISH. Nelson, D. M.; Romberg, G. P.; Prepejchal, W. [nd].

In Radiological Physics Division annual report, January–December 1971.

Fish samples were collected from Lake Michigan during 1970 and 1971 and analyzed for γ-ray emitting radionuclides. The Point Beach site had no history of radioactivity release prior to 1971 and measurements did not show an increase in radioactivity of organisms near the discharge point due to the section's small releases. The Big Rock site, however, has been exposed to routine releases for about 10 years. Many of the Big Rock fish contained measurable amounts of ^{65}Zn, ^{60}Co, ^{134}Cs, as well as ^{137}Cs, and ^{40}K. A table listing the contribution of Big Rock fish toward the maximum permissible ingestion of radionuclides is presented. (D.H.M.)

53170 (ORO–4066–5) INVESTIGATION OF THE UNUSUAL BEHAVIOR OF ^{137}Cs AND OTHER RADIONUCLIDES IN THE FLORIDA ENVIRONMENT. Progress Report, September 1, 1971–August 31, 1972. Gamble, J. F.; Ewel, K. C.; Lugo, A. E. (Florida Univ., Gainesville. Inst. of Food and Agricultural Sciences). 1972. Contract AT(40-1)-4066. 55p. Dep. NTIS.

The research study of ^{137}Cs activity and its role in the Florida environment are reported for the June 1971 to June 1972 period. Environmental levels of ^{137}Cs are summarized for rainfall, throughfall, stem flow, and ground water. Rainfall inputs are the same as ground water levels of activity (0.20 pCi/l). Stem flow averaged 3.65 pCi/l. A Bahama seawater sample had an activity of 7.0 pCi/l. Groundwater activity levels were the same in Fort Pierce as in Gainesville. Dairies 10 miles apart on similar soil and groundwater showed 76 pCi/l and no detection, respectively. Activity in an orange sample was found to be primarily in the rind. The juice showed 37 pCi/l and rinds 834 pCi/k. All of the mushroom samples collected in the hardwood ecosystem at Gainesville were mycorrhizal. Activity ranged from 450 to 47,000 pCi/k. Caterpillars grazing hickory leaves doubled the activity level of the resulting frass but did not accumulate ^{137}Cs burdens. Energy and matter results are presented for the major compartments in the hardwood ecosystem. A preliminary analog model has been simulated for the hardwood system and is included. (auth)

53171 (SRO–708–1) DISTRIBUTION AND CYCLING OF RADIOACTIVE ISOTOPES RELEASED INTO THE SAVANNAH RIVER SWAMP FOREST: ENVIRONMENTAL IMPLICATIONS. Progress Report, November 1, 1971–August 1, 1972. (Savannah River Ecology Lab., Aiken, S. C.). 1972. 44p. Dep. NTIS.

The distribution and cycling of radioisotopes released into the Savannah River swamp forest are being studied by reviewing literature on the subject, sampling the soil and vegetation of the area, measuring the ^{137}Cs content of these samples, and finally, determining the body burden of ^{137}Cs in biological specimens. Progress in each of these areas is reported. Data are presented on the animal, amphibian, bird, dragonfly, fish, plant, and reptile species of the area and the ^{137}Cs content or distribution in soils, plants, sagittaria roots, cotton rats, and snakes. (L.C.L.)

53172 DETERMINATION OF THE VARIATION OF RADIOACTIVE CONTAMINATION IN THE ENVIRONMENT BASED ON THE CONTAMINATION OF FOODSTUFFS. Kovacs, J. (Fovarosi Elelmiszerellenorzo es Vegyvizsgalo Intezet, Budapest). Izotoptechnika; 15: No. 2, 85–96(Feb 1972). (In Hungarian).

As a result of measurements in the last decade, no areas with significant food contamination were found. (auth)

Radiometric Techniques

Refer also to abstracts 52943 and 54670.

53173 (INP–793) DIFFERENTIAL INTERPRETATION OF GAMMA-RAY LOGS. II. CASE OF THE DYNAMIC GAMMA-RAY CURVE. Czubek, Jan Andrzej (Institute of Nuclear Physics, Krakow (Poland)). Mar 1972. 50p. Dep. NTIS (U. S. Sales Only).

The problem of digital interpretation of natural gamma-ray logs is presented for the case when the gamma-ray curve is measured in a continuous manner (logging speed ν) using a rate-meter with a time constant τ. The direct result of measurement, $J(z)$, along the borehole axis z is related to the specific radioactivity distribution, $q(z)$, being investigated by the equation: $J(z) + \nu\tau \cdot [dJ(z)/dz] = K \cdot \int_{-\infty}^{+\infty} \varphi_s(z - x) \cdot q(x) \cdot dx$ where K is the calibration constant and the kernel $\varphi_s(z - x)$ is given by the theory of gamma-ray logging. The solution of this equation is given in the form of a rapidly convergent series $q(z_0) = \Sigma\, J(z_j) \cdot d_j(p)$, where $p = 2,3,\ldots$ and $j = -p$ and where the coefficients $d_j(p)$ are given in the analytical form taking into account the borehole radius R, the length L of the detector, the thickness Δh of a hypothetical elementary layer, the effective gamma-ray absorption coefficient μ of rocks, the logging speed ν, and the rate-meter time constant τ. All numerical data needed for the calculation of the $d_j(p)$ coefficients are included. Examples of the gamma-ray log interpretation are presented. A method of transformation of the dynamic logging curve onto the static one is also given. (auth)

53174 BOREHOLE ACTIVATION ANALYSIS BY DELAYED AND CAPTURE GAMMA RAYS USING A ^{252}Cf NEUTRON SOURCE. Moxham, R. M.; Senftle, Frank E.; Boynton, G. R. (Geological Survey, Washington, D. C.). Econ. Geol.; 67: No. 5, 579–91 (Aug 1972).

Results of theoretical analysis and experimental comparison of the radiative capture and delayed gamma-ray activation techniques indicate the latter to be more efficient for the detection of copper, whereas the radiative capture method is preferable for nickel. A conservative lower detection limit for both copper and nickel is ~0.5%. Borehole spectra by both techniques were made in a copper- and nickel-bearing gabbro, utilizing a Ge(Li) propane-cooled detector. Al, Mn, Na, Mg, Cu, and V were readily activated and detected by the delayed method. H, Fe, Si, and Ni were not usually present in the delayed spectra but they responded well in the capture mode. It is shown that the borehole sonde can be configured to permit simultaneous delayed and capture spectra, permitting detection of all of these elements. Results of simulated borehole experiments indicate that, in the delayed gamma-ray mode, an infinite sample is achieved when the ore layer has vertical thickness of ~20 cm and a horizontal distance of ~10 cm into the wallrock. The depth resolution is thus relatively good but horizontal penetration through the wallrock is limited. (auth)

53175 RADIOTRACER ADSORPTION STUDY ON BAGUIO SOILS. Pablo, Benjamin B. (Philippine Atomic Energy Commission, Manila). Philipp. Nucl. J.; 2: No. 2, 211–14(1970).

Cationic tracers used in seepage tracing have been found to suffer great losses from adsorption. This investigation of the adsorptive properties of different soils near Baguio City was carried out to find a most suitable radiotracer. Chelation of these cations or conversion to complexes and addition of carrier improved the performance of these tracers. Sodium iodide (^{131}I) and potassium cobalticyanide (^{60}Co) were found to be the least adsorbed. (auth)

53176 XENON ISOTOPES IN TELLUROBISMUTHITE, BOLIDEN, SWEDEN. Srinivasan, B.; Alexander, E. C.; Manual, O. K. (Univ. of Missouri, Rolla). J. Inorg. Nucl. Chem.; 34: No. 8, 2381–96(Aug 1972).

The isotopic composition of xenon is reported in four different samples of tellurobismuthite, Boliden, Sweden, of varying tellurium content. It is observed that excess ^{129}Xe, ^{130}Xe, and ^{131}Xe, vary proportionately to the tellurium content of the sample. From the excess ^{130}Xe measurement, the half-life for double beta decay of ^{130}Te is calculated to be 2.51×10^{21} yr. From the observed excess of ^{128}Xe in the most tellurium rich sample, the half-life for the double beta decay of ^{128}Te is estimated to be greater than 2.7×10^{23} yr. It is shown that solar neutrino induced reactions on ^{128}Te and ^{130}Te do not contribute significantly to the observed excesses of ^{128}Xe and ^{130}Xe. The isotopic composition of xenon in a pyrite sample from the Boliden mine and in two samples of the cesium-rich mineral, pollucite, is used to examine previous hypotheses for the origin of excess ^{129}Xe and ^{131}Xe in tellurium ores. It is shown that these two xenon isotopes are produced in situ by nuclear reactions on tellurium. (auth)

53177 PROGRESS IN TL DATING AT RISOE. Mejdahl, V. (Danish Atomic Energy Commission, Risoe). Archaeometry; 14: No. 2, 245–56(Aug 1972).

The thermoluminescent dating technique employed at Risoe is outlined. The intensity of beta and gamma radiation was determined by means of the TL phosphors $CaSO_4$: Mn and $CaSO_4$: Dy, and the determination of accumulated exposure was based on quartz and feldspar inclusions with a size of 0.3 to 0.5 mm. Results are presented of a dating program comprising sherds, bricks, burned stones, and burned clay (from kilns) from seventeen excavation sites. The age of the sites ranged from 1600 AD to 4000 BC. (auth)

53178 ISOTOPIC COMPOSITION OF BIOGENIC SILICA. Labeyrie, Laurent (Centre National de la Recherche Scientifique, Gif-sur-Yvette, France). Compt. Rend., Ser. D; 274: No. 11, 1605–8(13 Mar 1972). (In French).

The elimination of organic matter and water from biogenic silica is necessary if the isotopic composition is to be measured.

The $^{18}O/^{16}O$ ratio obtained in this way is characteristic of the depositing conditions. The enrichment between this biogenic silica and water is about 3.87‰ at 10°C and varies slightly with temperature (about 0.03‰ for 1°C). (France)

53179 CORAL GROWTH RATES USING ^{228}Ra AND ^{210}Pb. Moore, Willard S. (Naval Oceanographic Office, Washington, D. C.); Krishnaswami, S. Earth Planet. Sci. Lett.; 15: No. 2, 187-90(Jun 1972).

Two radiometric methods are described to measure coral growth rates. The ^{228}radium method follows the theoretical model and is applicable to measurements of the last 30 years of growth. The ^{210}lead method is not ideal but may be used to document major changes in coral growth during the past 100 years. (auth)

53180 OXYGEN ISOTOPIC RATIOS OF SOME EVAPORITES FROM PRECAMBRIAN TO RECENT AGES. Sakai, H. (Okayama Univ., Tottori, Japan). Earth Planet. Sci. Lett.; 15: No. 2, 201-5(Jun 1972).

The $\delta\ ^{18}O$ values of eighteen marine evaporites of Precambrian to Recent ages were found to vary from +8 to 25‰ relative to SMOW, while the $\delta\ ^{34}S$ values previously measured by Thode and Monster vary from +10 to +38‰ relative to meteoritic sulfur. The results strongly suggest that the $\delta\ ^{18}O$ value of ocean sulfate varied with geologic age with a minimum at the Permian age. (auth)

53181 DATING ERROR. Wagner, G. A.; Reimer, M. (Univ. of Pennsylvania, Philadelphia). Nature (London); 237: No. 5349, 57(5 May 1972).

Some comments are offered on the communication by Nishimura on "Fission Track Dating of Archaeological Materials from Japan" (Nature, 230: 242(1971)) (NSA 25: 32078), and some errors are pointed out. A reply by Nishimura is included. (UK)

Thermal Effluents

Refer also to abstracts 53117, 53150, 55285, 55301, 55326, 55331, 55337, and 55338.

53182 (ANL–7860(Pt.3), pp 101-2) ECOLOGICAL STUDIES AT POINT BEACH NUCLEAR POWER STATION AND BIG ROCK POINT NUCLEAR POWER STATION: INTRODUCTION. Spigarelli, S. A. [nd].

In Radiological Physics Division annual report, January–December 1971.

Thermal studies at Point Beach consisted of: (1) thermal plume mapping and physical measurements related to plume dynamics; (2) chemical analyses of inshore waters affected by the thermal discharge; and (3) studies of the various aquatic communities to detect and quantify the potential effects of waste heat. A detailed map of the sampling stations is presented. Information regarding the locations and depths of each station relative to the Point Beach discharge is given. (auth)

53183 (ANL–7860(Pt.3), pp 103-8) MEASUREMENT OF MAJOR NUTRIENTS AND WATER QUALITY PARAMETERS AT POINT BEACH: 1971. Weschler, Mary Charles; Spigarelli, S. A.; Edgington, D. N. [nd].

In Radiological Physics Division annual report, January–December 1971.

The possible effects of the thermal discharge from a nuclear power plant on the aquatic environment were studied by conducting sampling program in the vicinity of the reactor operated by the Wisconsin Electric Company at Point Beach, Wisconsin. The parameters measured were pH, specific conductance, dissolved oxygen, total alkalinity, nitrate, nitrite, silicate (reported as silicon), and soluble orthophosphate. No major differences or trends were apparent for the values from various stations during any month. The only major trend that was apparent from the data was the seasonal (monthly) variation in the primary nutrients. (D.H.M.)

53184 (ANL–7860(Pt.3), pp 109-17) EFFECTS OF A THERMAL DISCHARGE ON THE INSHORE BIOLOGICAL COMMUNITIES OF LAKE MICHIGAN. Spigarelli, S. A.; Prepejchal, W. [nd].

In Radiological Physics Division annual report, January–December 1971.

The plankton, periphyton, and benthos communities of inshore waters were studied near the Point Beach Nuclear Power Station during 1971 to determine the biological effects of once-through cooling. In general, the observed biological effects of the thermal discharge were extremely localized and beyond the measurable plume boundaries were not statistically different from ambient conditions. (D.H.M.)

53185 (ANL–7860(Pt.3), pp 118-20) OBSERVATIONS OF FISH AT POINT BEACH NUCLEAR PLANT. Romberg, G. P.; Prepejchal, W. [nd].

In Radiological Physics Division annual report, January–December 1971.

A correlation was made of the discharge temperature and the type and quantity of fish collected at Point Beach Nuclear Power Plant for the period May through October 1971. (D.H.M.)

53186 (ANL–7860(Pt.3), pp 121-30) ACOUSTIC LOCATION TECHNIQUES TO STUDY THE DISTRIBUTION OF FISH IN THE VICINITY OF A THERMAL PLUME. Romberg, G. P.; Spigarelli, S. A. [nd].

In Radiological Physics Division annual report, January–December 1971.

The acoustic fish locating system was used to investigate the distribution of fish relative to a thermal plume. Fish observed during the day series of transects were primarily in schools that were concentrated in water warmer than 13°C and greater than 14 feet deep. Individual fish during the day and night series were more numerous in shallower water, but there appeared to be no preference for a temperature region. In neither series were fish observed in water warmer than 14.9°C, indicating that the near-field plume was not attractive to the inshore fish at this particular time. Many fish, however, are known to frequent the discharge channel in much warmer water. (D.H.M.)

53187 (ANL–7860(Pt.3), pp 131-40) AVERAGE TEMPERATURE MEASUREMENTS IN THE AQUATIC ENVIRONMENT USING THERMOLUMINESCENT DOSIMETERS. Oltman, B. G.; Eckerman, K. F.; Edgington, D. N.; Pohlman, T. [nd].

In Radiological Physics Division annual report, January–December 1971.

It is suggested that the temperature-induced fading of a thermoluminescent dosimeter can provide an economical method for monitoring thermal plumes. This technique could provide an estimate of the environmental temperature averaged over extended time periods. The wide range in the properties of various thermoluminescent materials indicates that the technique could be adapted to the various needs of ecologists. The precision of $CaSO_4$: Mn-Teflon dosimeters can be defined by 3 to 4% standard deviation. However, the precision may be considerably improved by precalibration to better than 2% standard deviation. The unit price for this type of dosimeter is about sixty cents. Therefore, it is possible to obtain several individual average temperature measurements at one site for low cost and with high precision. The thermograph, on the other hand, is a completely portable instrument that will produce a permanent record of temperature versus time with a relatively high degree of precision (±1°F). The types of thermographs available range in cost from 300 to 1500 dollars each and may restrict the number of sites that can be simultaneously observed. (auth)

53188 (ANL–7860(Pt.3), pp 250-69) ATMOSPHERIC CONSEQUENCES OF THERMAL DISCHARGES FROM POWER GENERATING STATIONS. Carson, James E. [nd].

In Radiological Physics Division annual report, January–December 1971.

Concern for the biological and ecological effects of heated water has resulted in legal actions that will prevent power companies from dumping the waste heat from the majority of their new generating units into rivers and lakes. Many nuclear- and fossil-fueled plants now under construction, and even some now on-line, are being required to change from once-through cooling systems to other methods, such as wet cooling towers, cooling ponds and spray canals, despite higher costs and lower thermal efficiencies. Yet, these alternate cooling procedures are not without their own environmental problems. The primary weather change due to once-through cooling on a large water body is a local increase in fogginess at the plant outfall. But the relative probability of significant local meteorological effects is much higher with alternate procedures, since these reduce the area of heat and moisture transfer. It is, therefore, concluded that, from a meteorological point of view, the least undesirable way to dispose of waste heat is by using once-through cooling on large water bodies. (auth)

53189 (ANL–7860(Pt.3), pp 270-98) SURFACE ENERGY BUDGET MEASUREMENTS OVER LAKE MICHIGAN. Frenzen, Paul; Hart, R. L.; Langs, R. K. [nd].

In Radiological Physics Division annual report, January–December 1971.

Consecutive hourly thermal energy budgets for the lake–atmosphere system are presented here in the form of smooth curves through the hourly averages. The observations provide an extensive body of quantitative information on the natural, vertical heat exchange over Lake Michigan, information which should be taken into account in the consideration of thermal pollution problems affecting the Great Lakes. In particular, variations of the undisturbed, natural heat exchange observed to occur in response to changing weather conditions, time of day, and season give useful insight into the thermal dynamics of cooling ponds, as well as the day-to-day energy balance of the lake observed. Further, the data suggest similar meteorologically-dependent behavior on the part

of the heat lost directly to the atmosphere from thermal plumes discharged in open waters. (auth)

53190 (ORNL-EIS-72-28) THERMAL EFFECTS ON AQUATIC ORGANISMS: ANNOTATED BIBLIOGRAPHY OF 1971 LITERATURE. Coutant, C. C.; Huber, E. E.; Pfuderer, H. A. (Oak Ridge National Lab., Tenn.). Sep 1972. Contract W-7405-eng-26. 162p. Dep. NTIS.

A bibliography on thermal effects on aquatic organisms is presented which includes 404 items published in 1971 and arranged in specified subject categories. Indexes on authors, keywords, and taxonomic names and a permuted index on titles are provided. (L.C.L.)

53191 PATIENT EARTH. Harte, John; Socolow, Robert H. New York; Holt, Rinehart, and Winston, Inc. (1971). 377p.

Environmental problems in contemporary American society, experiences in the 1930's Dust Bowl, the story of the Maya civilization, and essays on water, energy, and radiation are included. Separate abstracts were prepared for 3 papers. (M.C.G.)

For abstracts of individual papers see: 53192, 53193, and 53396.

53192 NUCLEAR POWER ON CAYUGA LAKE. Eipper, Alfred W. pp 112-31 of Patient Earth. /Harte, John. New York; Holt, Rinehart, and Winston, Inc. (1971).

Generation of electricity by steam electric stations is reviewed and Cayuga Lake is described. The utility company plan was to obtain 45°F cooling water from a depth of about 100 ft, warm it 20 to 25°F in the nuclear plant's condensers, and return it to the surface waters at a rate of 1100 ft^3/sec year-round. The effects of heated effluents and of radioisotopes released from the plant were studied. Public response to the studies is described along with the utility's response, and legislators' response. (M.C.G.)

53193 ENERGY. Harte, John; Socolow, Robert H. pp 276-94 of Patient Earth. /Harte, John. New York; Holt, Rinehart, and Winston, Inc. (1971).

Solar energy and the earth's heat balance, energy in the biosphere, magnitude of energy consumption, and impact on the environment are discussed. (M.C.G.)

53194 COPING WITH HEATED WASTE WATER DISCHARGES FROM STEAM-ELECTRIC POWER PLANTS. Cairns, John Jr. (Virginia Polytechnic Inst. and State Univ., Blacksburg). Bioscience; 22: No. 7, 411-19; 423(Jul 1972).

Some of the questions of our time are whether all ecological alteration is necessarily bad; whether or not ecological damage is a necessary consequence of technological progress; and whether it is possible to put man or nature "first." Waste heat added to the environment is of special interest, and it will be necessary to decide how much waste heat from steam-electric power plants may be placed in the environment without seriously degrading it. Predictions on the quantity of waste heat to be released to the environment, effects of power plant thermal effluents on aquatic ecosystems, methods other than surface water-discharge which may be used for dissipating or beneficially using waste heat, and the design and operating costs of modern cooling towers are discussed. It is concluded that we must accept the common goals of both environmental protection and energy production, and that biologists interested in environmental problems should devote their major efforts to predicting and judging the regional environmental effects, both adverse and beneficial, of waste heat discharge from power plants. (L.C.L.)

INSTRUMENTATION

Radiation Detection Instruments

Refer also to abstract 53187.

General Detectors and Monitors

Refer also to abstracts 53041 and 54078.

53195 (AD-737993) PROBLEM H01-32 AIRBORNE RADIAC. Progress Report, January 1–June 30, 1971. Peters, C. W.; Cook, D. C. (Naval Research Lab., Washington, D. C.). Jan 1972. 16p. (NRL-MR-2391). NTIS.

The results of computer calculations of the response of the scintillation spectrometer Airborne Radiac detector are summarized. The calculations were made as a function of altitude from 2,000 to 8,000 feet and for barometric pressures from 50 to 76 cm of Hg. Analytical equations for converting the detector response to dose rate at ground level are presented. The final status of the Airborne Radiac is reviewed. A Flyable Breadboard is complete and ready for flight testing. Other models are partially completed and are available as spare equipment or for measurements that may be required for future advanced development. (auth) (GRA)

53196 (COO-323-28) PROGRESS REPORT FOR PERIOD JUNE 1, 1971 TO MAY 31, 1972. (Illinois Benedictine Coll., Lisle (USA). Physical Sciences Lab.). 30 May 1972. Contract AT(11-1)-323. 26p. Dep. NTIS.

ARGON SYSTEMS—Ar–Hg, ionization of gaseous
BETA PARTICLES—effects on water vapor, energy for ion pair formation from
PLASTICS—preparation of air-equivalent, for ionization chambers
RADIATION DETECTORS, IONIZATION CHAMBER—development for environmental radiation
—development of small 0.5-cc air-equivalent, muscle-equivalent, and magnesium
VIBRATING REED ELECTROMETERS—improvement of Shonka
WATER VAPOR—radioinduced ionization of undeuterated and deuterated, energy for ion pair formation in beta (D.L.C.)

53197 (EGG-1183-2277) LINEARITY, TIME DOMAIN REFLECTOMETER, AND FOURIER ANALYSIS STUDIES OF AN EVACUATED COMPTON DETECTOR. Artuso, J.; Stevens, J. (EG and G, Inc., Goleta, Calif.). Sep 1971. Contract AT(29-1)-1183. 72p. (S-544-R). Dep. NTIS.

For California Univ., Livermore. Lawrence Livermore Lab.

The experimental procedure used to measure the dependence of the L-125A detector's relative sensitivity on the width of incident gamma pulses is described. When exposed to bremsstrahlung pulses whose widths were changed from 1 nsec to 4 μsec, the detector was found to be linear to within ±6%. The value of the time domain reflectometry (TDR) technique for improving the time response of the L-125A detector was established by comparing its results with those obtained by measuring the frequency response of the detector using a 50-psec bremsstrahlung pulse. These studies show that properly interpreted TDR techniques can give information that can be applied to the design of detectors with a higher frequency response than that of the L-125A detector. The peak linear output current of the L-125A detector was also measured and results are presented on the influence of excitation amplitude on detector linearity. (auth)

53198 (FRNC-TH-189) EXPERIMENTAL AND THEORETICAL STUDY OF GAS AMPLIFICATION IN A LOW PRESSURE CYLINDRICAL PROPORTIONAL COUNTER. Cukier, Michel (Paris Univ., Orsay (France)). 1971. 69p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

Methods of calculating the gas amplification in a low pressure cylindrical proportional counter are reviewed. It is shown that these methods do not account for the experimental results when the E/p (electric field to pressure) ratio exceeds 10^3 V/cm torr. A theoretical study of the form of the signal delivered by this type of counter was performed. From this study, the variation of the gas amplification was deduced as a function of the pressure and voltage for E/p values up to 10^5 V/cm torr. A theoretical electron avalanche model was developed for the calculations. It is shown that this model is satisfactory when the avalanche is produced in methane. The optimal conditions for the operation of the counter corresponding to various experimental situations can be predicted. (France)

53199 (LBL-585) HIGH RELIABILITY ENVIRONMENTAL RADIATION MONITORING AND EVALUATING SYSTEM. Stephens, L. D.; Dakin, H. S. (California Univ., Berkeley. Lawrence Berkeley Lab.). Jan 1972. Contract W-7405-eng-48. 25p. (CONF-720328-2). Dep. NTIS.

From sixth international congress on new trends in radiation protection; Bordeaux, France (27 Mar 1972).

Centralized monitoring and recording of accelerator-produced radiation fields at points within the Lawrence Berkeley Laboratory site is done by a telemetry system, which began operation in 1964. Using standard telephone lines, the system collects data simultaneously from all points, giving both the rate and the time-integrated intensity of radiation at each point. At the collection stations conventional counting equipment is used in conjunction with a simple device which converts scaler decade output signals into a form which is transmitted over telephone lines. This directly activates electromechanical event-recorder movements and impulse counters. Transmission of signals from two consecutive decades of a single scaler at a remote station over a single telephone line makes it possible to record a wide range of radiation intensities, extending over several orders of magnitude. For special applications apart from the regular operation of the system, telephone lines transmit 5-μs pulse signals and small count-rate metering currents with noise interference practically eliminated by means of ground isolation and common-mode rejection techniques. A computer program (PLOT DOG) is then used as a means of evaluating the environmental radiation. It provides a printout and bar graph plot of the daily or hourly radiation dose for each monitoring station. The data from each of these stations can be intercompared to provide information as to causes of significant increases of the machine-produced radiation or the effect of new shielding situations on the overall stray radiation patterns. (11 figures) (auth)

53200 (LBL-707(Summ.)) NEUTRON RADIOGRAPHY WITH A MULTIWIRE PROPORTIONAL CHAMBER: PERFORMANCE AND PROJECTIONS. Kaplan, Selig; Valentine, Kenneth; Kaufman, Leon; Perez-Mendez, Victor (California Univ., Berkeley. Lawrence Berkeley Lab.). Feb 1972. Contract W-7405-eng-48. 3p. (CONF-720607-26). Dep. NTIS.

From eighteenth annual American Nuclear Society conference; Las Vegas, NV. (18 Jun 1972).

A multiwire proportional chamber with delay-line readout can be employed for electronic neutron-radiographic imaging in a sensitive, highly selective, moderate-resolution system where low-intensity thresholds and high information yield per unit neutron dose are important considerations. The basic system is equivalent to an N × N array of 1- to 2-mm^2 neutron-sensitive proportional chambers. Independent of chamber size, signal detection and position location require only a single integrated detector and three amplifiers. One amplifier provides a prompt signal indicating an ionizing event anywhere in the chamber, and the other two each receive signals from delay lines which are capacitively coupled to each wire of one of two orthogonal grids that serve as cathode or anode planes of the proportional chamber. The two analog timing signals are then processed for display or storage. Neutron sensitivity is achieved by coating the inside surfaces of the chamber windows with neutron-to-charged-particle converting material. The performance of a small natural-boron-lined, prototype chamber, 3 × 4-cm sensitive area, was tested for thermal-neutron imaging. With 2-mm wire spacing and a single neutron converting surface 0.5% detection efficiency and 2-mm 10 to 90% resolution of a Cd knife edge or a Lucite step were achieved. Efficiency characteristics for neutrons of various energies are given. (1 figure) (R.W.R.)

53201 (NASA-TM-X-2440, pp 142-8) REAL-TIME SPECTRUM-TO-DOSE CONVERSION SYSTEM. Farmer, B. J.; Johnson, J. H.; Bagwell, R. G. (Advanced Technology Center, Inc., Dallas). Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

A system has been developed which will permit the determination of dose in real time or near real time directly from the pulse-height output of a radiation spectrometer. The technique has been demonstrated in the laboratory using the output of a NaI(Tl) anticoincidence gamma-ray spectrometer and a beta-gamma spectrometer which was flown on Gemini XII and also in space with the electron-proton spectrometer on the Radiation and Meteoroid Satellite. The technique involves the use of the resolution matrix of a spectrometer, the radiation energy-to-dose conversion function, and the geometrical factors, although the order of matrix operations is reversed. The usual method requires that a complete pulse-height spectrum (which is reasonably accurate statistically) be accumulated. The instrument resolution is then removed from this distribution giving the true radiation energy spectrum. This step requires the use of an inverted instrument

resolution matrix or a more accurate but more time-consuming iterative process. A geometric function and the radiation energy-to-dose function must then be applied to obtain dose. This requires the use of a significant remote or on-board computer and unnecessary and time-consuming computer operations if only the dose is required. The new technique yields a result which is mathematically identical to the standard method while requiring no matrix manipulations or resolution matrix storage in the remote computer. It utilizes only a single function for each type dose required (e.g., physical dose, biological dose) and each geometric factor involved (e.g., surface dose at a specific location inside a space vehicle). The dose functions are generated using the same resolution functions, geometric factors, and dose curves that would be used in the standard technique; however, the matrix manipulations are made only once for each function instead of each time a new pulse-height spectrum is obtained. Also, the dose may be calculated and accumulated while the data are being received, since it is not necessary to have a complete instrument spectrum before making a calculation. (auth)

53202 (NASA-TM-X-2440, pp 723-8) HIGH-RESOLUTION SEMICONDUCTOR DETECTOR FOR APPLICATIONS IN SPACE. Alexander, Peter; Shulman, Herman (Teledyne Isotopes, Westwood, N. J.). Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

Nuclear radiation detectors with volumes of ~1 cm^3 have been fabricated from single crystals of germanium-silicon alloy containing as much as 20 weight percent germanium. The properties of these detectors are discussed. Tests reveal that the gamma ray photoelectric peak efficiency of an alloy detector with only 12 weight percent germanium is ~4 times that of a silicon detector of equal volume. The alloy detector will operate with excellent energy resolution at -75°C. Operation at room temperature appears to be a good possibility. Storage for long periods at room temperature does not seem to adversely affect these devices. The results of preliminary radiation damage experiments suggest that the alloy detectors possess a radiation damage resistance far greater than that of silicon. (auth)

53203 (NASA-TM-X-2440, pp 874-83) EVALUATION OF TWO POSSIBLE FURTHER DEVELOPMENTS OF THE UK IN-FLIGHT RADIATION WARNING METER FOR SSTs. Wilson, I. J.; Eustace, R. C. (Atomic Weapons Research Establishment, Aldermaston, Eng.). Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

Various radiation measurements have been made to investigate 2 possible further developments of the present hybrid ionization and neutron detection system of the Dose-Equivalent Ratemeter commissioned for the SST Concorde, namely (i) A reduction of the mass of the moderator from that of the Anderson-Braun neutron-remmeter assembly, and (ii) the inclusion of a response to the nucleon flux responsible for the tissue-star component of the total dose-equivalent rate by means of a high atomic number material as a nucleon-neutron converter within the moderator. Radiation situations at SST cruising altitudes (~20 km) due to solar proton flares were simulated approximately both in the stratosphere and on the ground. Actual stratospheric situations due to galactic cosmic radiation with a limited range of quality factor values (2 to 4) were encountered during slow ascents by balloons to 36 km from Aire-sur-Adour (France). Synthetic situations obtained from high and low energy accelerator radiations were used to obtain radiation distributions having a larger range of quality factor values (1½ to 9) than experienced in the stratosphere. The measurements made in these simulations related to the directly ionizing, neutron and tissue-star components of dose-equivalent rate. The stratospheric and high energy accelerator experiments taken together with results from both radioactive and machine neutron sources indicated 2 conclusions. Firstly that, due to the restricted range of neutron spectra encountered in the stratosphere, a significant and welcome reduction of the mass of the moderator by 4 kgm could be made, provided the moderator is clad with cadmium or some other slow neutron absorber. Secondly, that to achieve a tissue-star response with a lead insert would result in a net increase in moderator-assembly weight of 5½ kgm. Hence the lead insert proposal was abandoned, while the potential moderator reduction is being exploited. A reduced moderator geometry compatible with the existing electronics package was derived; its oversensitivity with respect to the Anderson-Braun neutron remmeter was determined for a number of fast neutron energies. Two different methods of correcting the oversensitivity—a slow neutron absorber within the moderator and a reduced sensitivity boron trifluoride counter—were tested. As a result, a new—reduced weight—version of the In-Flight Radiation Warning Meter for SSTs can now be designed in detail. (auth)

53204 (RDT-C-15-11-T(8-72)) BF_3 GAMMA TOLERANT NEUTRON DETECTOR TUBES. (Division of Reactor Development and Technology (AEC), Washington, D. C.). Aug 1972. 19p. RSO.

This tentative standard describes the requirements for a high-gamma-tolerant, BF_3-filled proportional counter for use in neutron detection systems requiring operation in gamma flux environments to 10^3 R/h. Specifically, this detector will be used to detect thermal neutrons in a neutron monitoring system, and will be installed in the vicinity of primary sodium piping system. This standard applied only to the detector. Required performance characteristics are given in detail, and the tests to assure this performance are described. Six test report certificates are included in the appendix. (1 table) (R.W.R.)

53205 (TID-26132) HEALTH PHYSICS MANUAL. (Oak Ridge Associated Universities, Inc., Tenn. (USA). Special Training Div.). 1971. 213p. Dep. NTIS.

Some general information of interest to the health physicist is presented first. This is followed by instructions for 31 laboratory exercises. (R.W.R.)

53206 THIN POLYPROPYLENE WINDOW PROPORTIONAL COUNTERS FOR THE OBSERVATION OF COSMIC SOFT X-RAYS. Kato, Takako; Kohno, Tsuyoshi; Nagase, Fumiaki; (and others) (Nagoya Univ.). Jap. J. Appl. Phys.; 11: No. 9, 1351-6(Sep. 1972).

Thin polypropylene window proportional counters are being developed for rocket observations of cosmic soft x-rays. Film thicknesses down to half a micron have been obtained, and practically all wavelengths shorter than 100 Å have become observable. This technique is also applicable to the detection of electrons above a few keV whose existence at rocket altitudes has been recently discovered. The preparation of thin polypropylene film, its application to proportional counters, and the associated gas control systems are described. An electrostatic shutter which discriminates between soft x-rays and low energy electrons is tested, and its function in the ambient plasma is also discussed. (auth)

53207 BINOMIAL DISTRIBUTION AND GAUSSIAN DISTRIBUTION IN NUCLEAR RADIATION MEASURING. Andresen, E. G. (Technische Fachhochschule, Berlin). Kerntechnik; 14: No. 5, 226-31(May 1972). (In German and English).

Fundamental statistical methods for evaluating counting results in radiation measurements are reviewed. Topics include the binomial distribution, safety systems in 2-out-of-3 logic, the Gaussian distribution, use of probability coordinates, and statistical uncertainty of pulse counts. (W.H.K.)

53208 TEILCHEN-DETEKTOREN. (Particle Detectors). Allkofer, Otto Claus. Thiemig-Taschenbuecher, Band 41. Munich; Verlag Karl Thiemig KG (1971). 251p. DM 19,80.

Topics include the interaction of radiation and particles with matter, ionization chambers, proportional counters, Geiger-Mueller counters, spark chambers, scintillation detectors, semiconductor detectors, Cherenkov counters, neon flash tubes, counter hodoscopes, cloud chambers, bubble chambers, nuclear emulsions, plastic detectors, other detectors, and counting fluctuations. (W.H.K.)

53209 CHERENKOV COUNTING OF BETA-EMITTING RADIONUCLIDES. Santoso, Daniel. College Park, Md.; Univ. of Maryland (1972). 167p. University Microfilms Order No. 72-21,131. Thesis.

A theoretical and experimental study was made on the role of a number of parameters in Cherenkov counting of beta emitters in commercially available liquid scintillation systems. A modified form of the Frank and Tamm equation was used to evaluate the amount of light produced by the beta particles in the medium. The photon yield improves with increasing refractive index and decreases with increasing density. The index of refraction also determines the value of the Cherenkov threshold and thereby determines the fraction of beta particles capable of generating photons via the Cherenkov effect. This fraction was computed from the Fermi distribution and the value of the threshold energy. The influence exerted by refractive index and density are more readily observed with low energy than with high energy beta particles. The experiments were conducted using a Nuclear Chicago Liquid Scintillation Counter which was interfaced with a Nuclear Data Multichannel Analyzer. The original photomultipliers were replaced by phototubes having a quartz window enabling detection of ultraviolet as well as visible light. Pre- and main amplifiers with provisions for pulse shaping were installed in place of the original amplifier circuits. Above five ml the solvent volume was found to have little, if any, effect upon the count rate. There exists a modest variation in counting efficiency from solvent to sol-

vent. An unusually high detection efficiency was observed with benzene and toluene. As a result of experiments showing the presence of a small hump in the spectra when the latter two solvents were used, which disappeared upon addition of a few μl of $CHCl_3$, it was postulated that the high detection efficiency was due to radioluminescence occurring in addition to the Cherenkov effect. Investigations of the channel ratio method revealed that appropriate window widths can be selected to enable the use of a linear interpolation method for quenching correction. The quench curves obtained are linear, except in the region of very low detection efficiencies. The continuous distribution of the beta spectrum makes the Cherenkov method far from ideal for the separate quantitative assay of two or more nuclides in a mixture. However, results of experiments with $^{24}Na + ^{42}K$ and $^{32}P + ^{36}Cl$ showed that a precision of less than ten percent can be achieved in many cases. The greater the difference in energy between the two isotopes, the better the precision attainable. (Diss. Abstr. Int., B)

53210 DIAPHRAGM-LESS RADIOACTIVE RADIATION COUNTER. Kawashima, Nobuki (to Tokyo Univ.). U. S. Patent 3,678,274. 18 Jul 1972. Priority date 29 Oct 1969, Japan.

A radioactive radiation counter is provided with a counter chamber having a diaphragm-less open window, and two collecting electrodes are disposed in said chamber and separated from each other. A gas to be ionized is injected in a pulse into the chamber intermittently to create a gas cloud for a short duration in the space where the electrodes are disposed, and a voltage pulse is applied across the electrodes during the presence of said gas cloud between the electrodes to operate the counter in order to measure the radiation coming into the chamber during the voltage being applied to the electrodes. Because of the absence of a diaphragm in the ray entrance window of the counter chamber, the absorption of radiation energy in a diaphragm is avoided and thereby it is possible to measure radiations of energy less than 1 keV. (auth)

53211 SOLVENT COMPOSITION FOR LIQUID SCINTILLATION COUNTING. Webb, Richard V. (to Eastman Kodak Co.). U. S. Patent 3,677,964. 18 Jul 1972. Filed 31 Dec 1970.

A solvent composition is proposed for dissolving samples for liquid scintillation counting consisting essentially of (a) a solvent suitable for use in liquid scintillation counting, (b) at least one quaternary ammonium base selected from the group of the formula:

$$[R'-\overset{\overset{X}{|}}{\underset{\underset{R''}{|}}{N}}-CH_3]^+OY^-$$

wherein R' and R'' are alkyl radicals of from 4 to 18 carbon atoms, X is selected from the group consisting of methyl and benzyl radicals, and Y is selected from the group consisting of hydrogen and lower alkyl radicals, the predominant class of quaternary ammonium consisting of the group wherein R' and R'' contain from 4 to 14 carbon atoms, (c) methanol, and (d) an alcohol selected from the group consisting of t-pentyl alcohol and 2-methoxy ethanol. The quaternary ammonium base preferably is didodecyldimethylammonium hydroxide or methoxide, and is present in at least 0.25 molar concentration. The solvent advantageously is toluene, benzene, xylene, or dioxane, and is present in 60–70% by volume. The t-pentyl alcohol or 2-methoxy ethanol preferably are present in 4–10% by volume. (auth)

53212 GEIGER-MUELLER COUNTER DESIGNED TO MEASURE REPRODUCIBLY ACTIVITIES RETAINED ON RESIN COLUMNS. Heurtebise, M.; Lubkowitz, J. A. (Instituto Venezolano de Investigaciones Cientificas, Caracas). Anal. Chem.; 44: No. 11, 1918-21(Sep 1972).

A G–M counter was designed which consists of two anodes that are contained within one cylindrical counter. The detector efficiency for 2-MeV β particles was estimated by using an ^{128}I source and found to be good. (4 figures, 1 table) (R.W.R.)

53213 PERFORMANCES OF A PROPORTIONAL CHAMBER WITH INTERMEDIATE HIGH VOLTAGE PLANES. Aebischer, D. (Univ., Geneva); Hess, R.; Marcoli, R.; (and others). Helv. Phys. Acta; 45: 57-60(1972).

Results of work to increase the signal amplitude on the wires of multiwire proportional chambers are presented; the goal was to reduce the large amount of expensive electronics ordinarily needed. The region of electron multiplication around the wires can be enlarged by introducing two intermediate high-voltage planes. The signal amplitude obtained is shown as a function of voltage and gas mixture. and global efficiency is plotted against voltage. Time

53214 tion was found to be 9 ns. (4 figures) (R.W.R.)

GAMMA CAMERA IN MALIGNANT DISEASE. THE GAMMA CAMERA. McCready, V. R. (Inst. of Cancer Research, Sutton, Eng.). Proc. Roy. Soc. Med.; 65: No. 8, 703-5(Aug 1972).

The diagnostic use of the gamma camera in conjunction with scintillation scanning is briefly reviewed under the following headings: dynamic studies throughout the body; thyroid; liver; pancreas; spleen; kidneys; and skeleton. (UK)

53215 DIGITAL STEREOSCINTIGRAPHIC EXPERIMENTS WITH A GAMMA-CAMERA. Larsson, E. Ingemar (Univ. of Lund, Sweden). Acta Radiol., Ther., Phys., Biol.; 11: No. 2, 135-44(Apr 1972).

A simple and cheap method for stereoscintigraphy using conventional gamma-camera equipment and digital storage-facilities is described. Some experimental results are presented and discussed. (auth)

53216 PORTABLE TRITIUM PROPORTIONAL COUNTER (3 Apr 1972) (Engineering Materials). (California Univ., Livermore. Lawrence Radiation Lab.). (CAPE–2204).

41 drawings.

A γ-compensated tritium proportional counter indicates and records the count rate corresponding directly to the T air concentration (either as HTO or ^3H) even if the area background changes up to 5 mR/hr in a uniform radiation field. The counter is a large-area, thin-window gas-flow counting system which measures 5 μCi/m^3 of tritium oxide in the presence of 3 mR/hr of a uniform γ-radiation field. To provide γ-background discrimination, two detectors are used: (1) the "tritium" detector which detects all radiation and (2) the "background" detector which has an infinitely thick window for tritium but detects all other radiation. Subtracting the analog output of (2) from the analog output of (1) gives a dc voltage proportional to the T count rate. (41 drawings) (For details see TID-4100 Suppl. 70) (see also 23: 50122 and 26: 9311) (F.S.)

53217 RANDOM DRIVER (5 May 1972) (Engineering Materials). (Los Alamos Scientific Lab., N. Mex.). (CAPE–2240).

23 drawings.

A random source interrogation system is described. The system consists of a compact, nondestructive assay instrument used principally to determine the ^{235}U content of containers up to 5 gallon capacity. An Am–Li random neutron source (of strength $\sim 5 \times 10^5$ n/s) is used to induce fissions in the ^{235}U present in the sample. Induced fissions are observed by coincidence counting the time-correlated fission neutrons with two fast plastic scintillation detectors. By requiring the detection of neutrons in both detectors within a time interval of ~50 nsec, it is possible to distinguish the time-correlated induced fission neutrons from the randomly produced source neutrons. The "Random Driver" has been used to assay ^{235}U in a wide variety of matrix materials: U_3O_8, UO_3, UNH, and UF_4, and in various sample configurations. The sensitivity for ^{235}U detection depends strongly on sample size: ~5 g ^{235}U for two-liter samples and ~25 g ^{235}U for 5 gal containers. The assay time depends on the amount of ^{235}U in the sample and the assay precision desired. An assay time of ~100 sec is required to obtain a 10 g standard deviation on 200 g of ^{235}U in a two-liter bottle. Samples containing up to ~10 kg ^{235}U have been assayed with nearly linear calibration curves. It should be possible to assay fertile isotopes, such as ^{238}U, with this instrument by using both a subthreshold Am–Li source and a superthreshold (>1 MeV) random source, such as AmB or AmF. This "two-spectrum" interrogation technique will enable the Random Driver to assay both ^{235}U and ^{238}U content. (23 drawings) (For details see TID-4100 Suppl. 72) (F.S.)

53218 DOSE RATE RECORDING MONITOR (27 Dec 1971) (Engineering Materials). (New York Operations Office (AEC), N. Y. Health and Safety Lab.). (CAPE–2257). 40 drawings.

This monitor, with a sensitivity of $\sim 10^{-4}$ A/μR/hr and an unusual degree of stability, measures the natural, or normal environmental levels of γ radiation. An internal impulse-driver strip-chart recorder provides information in a form suitable for permanent storage of incident radiation levels for subsequent analysis. A stainless-steel-walled 10-in. dia spherical ionization chamber is filled with ultra-pure Ar to a pressure of 20 atmospheres. A MOSFET electrometer provides current amplification to a level compatible with the recorder. The system operates for over two weeks on its internal batteries or it may be powered from an ac powered supply. The unit is packaged in two water-proof housings. One contains the ionization chamber and the electrometer and the other section has the battery supply, controls, strip-chart recorder, and an automatic circuit for checking the electrometer. (40 drawings) (F.S.)

53219 HIGH-RATE DIRECT-COUPLED PREAMPLIFIER (Feb 1972) (Engineering Materials). (California Univ., Livermore. Lawrence Radiation Lab.). (CAPE–2208).

15 drawings.

This preamplifier is used with high-energy Ge-detector systems for fast counting of high-energy γ events. Good resolution is pos-

sible with recycling and data can be obtained with and without pile-up rejection for count rates up to 150,000 counts/sec. Resolution without pile-up rejection for ^{60}Co is 2.50 keV fwhm at 75,000 counts/sec (1.5 μsec shaping). The preamplifier does not require pole-zero compensation. After single differentation, the pulses return precisely to the baseline. The charge-sensitive loop uses a cooled FET input stage. (15 drawings) (For details see TID-4100 Suppl. 70) (see also 26: 6835) (F.S.)

53220 COMPUTER-CONTROLLED IN-LINE MONITORING SYSTEM (18 Nov 1971) (Engineering Materials). (Savannah River Operations Office (AEC), Aiken. S. C.). (CAPE-2237).

5 drawings.

The computer-controlled in-line system collects data from detectors, which are monitoring a chemical process stream containing radionuclides, to compute control parameters from the data, and to supply information and instructions to production operators. Three types of detectors monitor the process stream: a high-resolution Ge(Li) detector produces a gamma spectrum from which specific radionuclides can be identified, a BF_3 neutron detector measures gross neutron activity, and a NaI γ detector coupled to a single-channel pulse-height analyzer measures the high-energy gross γ activity. (For details see TID-4100 Suppl. 71) (F.S.)

53221 PROPORTIONAL COUNTERS FOR THE LOCALISATION OF IONISING RADIATION. Hough, J.; Drever, R. W. P. (Glasgow Univ.). Nucl. Instrum. Methods; 103: No. 2, 365-72 (1972).

Gas proportional counters which can be used for the localization of ionizing radiation in one or two dimensions are described. The technique of charge division on a resistive electrode is used to obtain position information, this electrode being the anode in the linear detector. In two dimensions the counter signal is obtained in a new way, from two induction grids placed between the anode and the cathode, each grid providing position information in one direction. Application of the two-dimensional counter for x-ray imaging is illustrated. These counters combine ease of readout with good spatial resolution; in the one-dimensional detector the standard deviation of position measurements can be 0.04% of the sensitive length. (9 figures) (auth)

53222 MAGNETO-, SPARKO-, AND THERMOSTRICTIVE PHENOMENA IN THIN WIRES. Bichara, M. R. E.; Jauch, K. M. (Univ., Geneva). Nucl. Instrum. Methods; 103: No. 2, 385-7 (1972). (In French).

As part of the work on a novel spark chamber technique, an effort was made to elucidate the nature of "sparkostriction" (shock waves produced in wires due to sparks) by using a high-power pulsed and focused laser beam to produce similar signals on the same wires. However, it was found that the signals due to sparks are linearly proportional to the input power, whereas those due to the laser are proportional to the square root of the input power; the latter result is supported on theoretical grounds. (4 figures) (auth)

53223 NEUTRON IRRADIATION MONITOR FOR USE WITH Ge(Li) DETECTORS. Wilenzick, R. M. (Univ. of Texas, Houston). Nucl. Instrum. Methods; 103: No. 2, 429-30(1972).

A fission-track dosimeter is suggested as a method of monitoring the integrated fast neutron flux incident on a Ge(Li) detector in order to prevent overexposure and subsequent radiation damage. (auth)

53224 ION-CHAMBER DEVICE AS ELECTRONIC SWITCH IN HIGH RADIATION FIELD. Chakraborty, P. P.; Sahasrabudhe, S. G.; Samant, R. K. (Bhabha Atomic Research Centre, Bombay). Nucl. Instrum. Methods; 103: No. 2, 411-14(1972).

The design of an ionization chamber which makes use of the change in ionization current to record and control irradiation times of samples in a pneumatic transport system installed in a reactor is described. (4 figures) (auth)

53225 METHOD FOR RAPID COMPARISON OF ANGULAR DISTRIBUTION ATTENUATION COEFFICIENTS FOR DETECTORS OF ARBITRARY GEOMETRY. Avignone III, F. T. (Univ. of South Carolina, Columbia). Nucl. Instrum. Methods; 103: No. 2, 225-8(1972).

A very simple method for comparing a well-known angular correlation or distribution attenuation coefficient, Q_k, of one geometry to that of a detector geometry which is not known was developed. The method consists of generating an artificial angular distribution of γ rays by placing the radioactive source on the axis of a cylindrical absorber which has a circular inside surface and an outside surface shaped so as to transmit γ rays with a relative probability given by $W(\theta) = 1 + A_2P_2(\cos\theta)$. The observed directional distributions are found to be very close to $W(\theta)$ given above. The method was tested for both NaI(Tl) and Ge(Li) detectors in several counting geometries. (3 figures) (auth)

53226 MORE ACCURATE DETERMINATION OF THE ATMOSPHERIC CONCENTRATIONS OF RADON DAUGHTERS BY AN α-SPECTROMETRIC EXTRAPOLATION METHOD. Goumnerova, L.; Minev, L. (Sofia Univ.). Nucl. Instrum. Methods; 103: No. 2, 253-6(1972).

RaA and RaC were recorded separately with a Si(Au) surface barrier detector. Their decay curves were plotted, and the values of their activity on the filter at the end of the accumulation were found by extrapolation. (3 figures) (auth)

53227 MEASUREMENTS OF THORON IN THE ATMOSPHERE. Shimo, Michikuni; Ikebe, Yukimasa; Kawano, Minoru (Nagoya Univ., Japan). Nippon Genshiryoku Gakkaishi; 14: No. 8, 415-21(Aug 1972). (In Japanese).

A study was made on a method for calibrating the ionization current to be determined when measuring thoron concentration with an ionization chamber. The ionization current generated by the thoron exhausted from RdTh solution would appear to be controlled mainly by the bubbling velocity in the bottle, and the reciprocal of the current is a linear function of the reciprocal of the velocity. The ionization current was calculated from thoron concentration by taking the following three conditions into consideration: loss of ions by columnar recombination, loss of range by the chamber wall, and the condition of the air flow through the chamber. The calibrated and measured values coincided well with each other. Thoron concentrations in the atmosphere were measured on the university campus in Nov. 1968, and the concentration was found to be $0.3 \sim 0.6 \times 10^{-18}$ Ci/cm^3 at 1 m above the ground surface. (7 figures) (auth)

53228 FIRST STAGE OF AN ASSEMBLY OF PROGRAMS FOR THE COMPUTERIZED PROCESSING OF DIGITAL SCINTIGRAPHIC DATA. Portmann, M.-C.; Legras, B.; Legras, J.; Martin, J. (Univ., Nancy). J. Biol. Med. Nucl.; 7: No. 27, 22-30(1972). (In French).

The general characteristics of a package of programs for the processing of clinical scintigraphic data are described. Various curve- and surface-smoothing techniques are used in conjunction with statistical analysis methods according to the problems studied. In certain other cases a single averaging technique is used to produce smoothed lines, determinations of the activities of several zones being sufficient for the purpose required. Such techniques have been tested with simulated scintigraphs or models, and are beginning to find applications in medicine. (France)

Radiation Dosimeters

Refer also to abstracts 52979, 53397, 53420, 54895, 54922, and 55457.

53229 (COO-1105-172) FAST NEUTRON RADIATION DAMAGE EFFECTS IN CRYSTALLINE ANTHRACENE AND EVALUATION AS A DOSIMETRIC TECHNIQUE. Moran, P. R. (Wisconsin Univ., Madison. Dept. of Physics). 1971. 6p. (CONF-710714-2). Dep. NTIS.

From Workshop on personnel neutron dosimetry; New York, N. Y. (8 Jul 1971).

Preliminary results of a study on the fast neutron radiation damage effects on the optical properties of metastable excitons in anthracene are presented. The relative annihilation blue fluorescence total yield under steady state red light excitation and the delayed fluorescence decay curve after pulsed red light illumination were measured. The fading and stability properties were found to be excellent. It is concluded that the damage effects in anthracene offer some potential for selected dosimetric applications. (W.H.K.)

53230 (NASA-TM-X-2440, pp 138-41) HEAVY-ION PASSIVE DOSIMETRY WITH SILVER HALIDE SINGLE CRYSTALS. Childs, Charles B. (Univ. of North Carolina, Chapel Hill); Parnell, Thomas A. Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

A method of detecting radiation damage tracks due to heavy particles in large single crystals of the silver halides is described. The tracks, when made visible with simple electrical apparatus, appear similar to tracks in emulsions. The properties of the crystals, the technique of printing out the tracks, and evidence concerning the threshold energy for registering particles indicate that this method may find application in heavy ion dosimetry. The method has been found to be sensitive to stopping He nuclei and relativistic M group cosmic rays. Some impurities strongly influence the "decoration" or printout of the tracks, and the effects of these impurities are discussed. (auth)

53231 (NASA-TM-X-2440, pp 149-56) HIGH-Z-PARTICLE APOLLO ASTRONAUT DOSIMETRY WITH PLASTICS. Benton, E. V.; Henke, R. P. (Univ. of San Francisco). Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

On Apollo missions, the individual astronaut's high Z particle exposure is measured by means of Lexan polycarbonate plastic. These layers form one component of the passive dosimetry packets worn in the constant wear garment. They serve as threshold type, high Z, charged particle track detectors, recording only the very highly ionizing particles such as E < 6 MeV/amu ^{12}C, E < 45 MeV/amu ^{28}Si, E < 250 MeV/amu ^{56}Fe, etc. The detectors yield information on the particles' charge, energy, and direction of travel. These data, in turn, are used to obtain the track fluence, the stopping particle density as an integral Z distribution, and the particles' integral LET spectrum. Some of the data gathered on Apollo missions 8-13 are presented. (auth)

53232 (NASA-TM-X-2440, pp 435-7) METHODS AND APPROACHES TO DOSIMETRY. Rossi, Harald H. (Columbia Univ., New York). Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

The development of a dosimetric system capable of determining energy depositions in tissue regions that are smaller than a few 100 nanometers is projected. These objectives are met by evaluation of the data produced by a macro-subsystem and a micro-subsystem. Both systems are in essence multiple ionization chambers that are normally operated in a gated pulse mode. The macro-system yields absorbed radiation dose as a function of location in a phantom of the human trunk when it operates in the dose mode; it registers only those sections as a signal in which the primary particle or any of its secondaries have passed, in the pulse mode. The function of the micro-system is to provide detailed information of the track structure by determining lateral energy spread due to delta ray formation or other secondary particle production. (GRA)

53233 (NASA-TM-X-2440, pp 466-70) SELECTION AND USE OF TLDs FOR HIGH-PRECISION NERVA SHIELDING MEASUREMENTS. Woodsum, H. C. (Westinghouse Electric Corp., Large, Pa.). Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

An experimental evaluation of Thermoluminescent Dosimeters (TLDs) was performed in order to select high precision dosimeters for a study whose purpose is to measure gamma streaming through the coolant passages of a simulated flight type internal NERVA reactor shield. The criteria for selection of the dosimeters was that they should be reproducible within +2% and some must have spatial resolution within +1.5 mm. The experimental procedure was to expose batches of 50 to 100 CaF_2 and LiF chip, mini, and micro TLDs to ^{60}Co radiation by mounting these dosimeters on a rotating wheel (to minimize positional differences). ^{60}Co radiation was used since it approximates the average energy of the gammas entering the shield. The 30 Ci source was placed ~150 cm from an aluminum wheel 51.1 cm dia. by 0.079 cm thick on which dosimeters were taped. All TLDs had been annealed for 1 hour at 400°C followed by 17 hours at 80°C prior to exposure. Reading of the TLD exposures was performed on a digital readout system. All dosimeter data were processed by the TLDEVAL code which calculates the mean standard deviation variance for each dosimeter and fractional standard deviation of the mean. Based on this study, the CaF_2 chip TLDs are the most reproducible dosimeters with reproducibility generally within a few percent, but none of the TLDs tested met the reproducibility criterion of ±2%. The microdosimeters were the least reproducible to the point of not being usable for measurements below several hundred rads. The dosimeters tested are linear with dose over the range of 1 to 180 rads within ±10% and fading of dosimeters after exposure was found to be negligible within the accuracy of the measurements. The non-reproducibility of ^{7}LiF mini TLDs is not presently understood, but may be due to a combination of the following: lack of sensitivity (compared to comparable CaF_2 dosimeters), non-radiation-induced thermoluminescence, or radiation damage from previous reactor irradiations. These effects are currently under further investigation. (auth)

53234 (NASA-TM-X-2440, pp 609-13) PORTABLE ABSORBED-DOSE MEASURING INSTRUMENT WITH GAMMA DISCRIMINATION. Quam, W. M.; Wilde, W. O. (EG and G, Inc., Santa Barbara, Calif.). Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

The characteristics of an electronic instrument for measuring the radiation dose absorbed by tissues are presented. The detector is a sphere of tissue-equivalent plastic with a single wire located on a diameter of the sphere. The electronic circuits and method of operation of the detector are described. Advantages are the small size and easy portability plus ability to selectively measure neutron and gamma plus neutron events. (auth) (GRA)

53235 (NASA-TM-X-2440, pp 944-56) ADVANCED-DOSIMETRY SYSTEMS FOR THE SPACE TRANSPORT AND SPACE STATION. Wailly, Louis F. (Air Force Academy, Colorado Springs, Colo.); Schneider, Marion F.; Clark, Benton C. Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

Instrumentation to measure the operationally significant high energy radiations encountered in future manned spaceflight is of fundamental importance in ensuring astronaut safety, system survivability, and ultimate mission success. Advanced dosimetry systems concepts that will provide automated and instantaneous measurement of dose and particle spectra are described. Proposed are systems to measure dose rate from cosmic radiation background to >3600 rads/hour. Charged particle spectrometers, both internal and external to the spacecraft, to determine the mixed field energy spectra and particle fluxes for both real time on-board and ground based computer evaluation of the radiation hazard are described. New and advanced automated passive dosimetry systems consisting of thermoluminescent dosimeters and activation techniques are proposed for recording the dose levels for twelve or more crew members. This system will allow automatic on-board readout and data storage of the accumulated dose and can be transmitted to ground after readout or data records recovered with each crew rotation. (auth)

53236 (NASA-TM-X-2440, pp 958-73) EXPERIMENTAL ACTIVE- AND PASSIVE-DOSIMETRY SYSTEMS FOR THE NASA SKYLAB PROGRAM. Schneider, Marion F.; Janni, Joseph F.; Ainsworth, Glenn C. (Air Force Weapons Lab., Kirtland AFB, N. Mex.). Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

Active and passive dosimetry instrumentation to measure absorbed dose, charged particle spectra, and linear energy transfer spectra inside the command module and orbital workshop on the NASA Skylab Program in 1972 has been developed and tested. The active dosimetry system consists of one integral unit employing both a tissue equivalent ionization chamber and silicon solid state detectors. The instrument measures dose rates from 0.2 millirad/hour to 25 rads/hour, linear energy transfer spectra from 2.8 to 42.4 keV/micron, and the proton and alpha particle energy spectra from 0.5 to 75 MeV. The active dosimeter is equipped with a portable radiation sensor for use in astronaut on-body and spacecraft shielding surveys during passage of the Skylab through significant space radiations. Data are transmitted in real time or are recorded by an on-board spacecraft tape recorder for rapid evaluation of the radiation levels. The passive dosimetry systems consist of twelve (12) hard-mounted assemblies, each containing a variety of passive radiation sensors which are recoverable at the end of the mission for analysis. The passive dosimeters consist of calcium and lithium fluoride thermoluminescent dosimeters, special discharge ionization chambers, activation foils, Ilford G.5 and K.2 nuclear emulsions and plastic heavy particle track dosimeters. The passive dosimeters record the total mission dose from 5 millirads to 5000 rads and the linear energy transfer spectra from 0.20 to >85 keV/micron. (auth)

53237 (RD/B/N-2369) USE OF Ge(Li) DETECTORS IN HIGH DOSE RATE GAMMA SPECTROMETRY. Woollam, P. B.; Jones, L. T. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Jul 1972. 10p. Dep. NTIS (U. S. Sales Only).

The use of a Ge(Li) detector system for measuring spectra in high dose rates is discussed. Results are presented of measurements at dose rates up to 2.5 rad h^{-1} with a typical radium spectrum taken at 1.2 rad h^{-1}. (auth)

53238 AN INTRAUTERINE DOSIMETER. Parker, H. M.; Endres, G. W. R.; Wheeler, R. G. (Battelle-Northwest, Richland, Wash.). Health Phys.; 23: No. 3, 389-90(Sep 1972).

In order to measure the long term integrated radiation dose delivered to a nonsurgically implanted dosemeter the possibility of incorporating a thermoluminescent dosimeter (TLD) into the structure of an intrauterine contraception device (IUD) was investigated. Care must be taken to ensure isolation of the thermoluminescent materials from body fluids. The relative sensitivities and fading properties of LiF, CaF_2 : Mn and CaF_2 : Dy are considered. The acceptable replacement cycle, the size and weight of the proposed dosemeters, readout facilities, and encapsulation are discussed. The preliminary results suggest that the use of LiF to measure dose at uterine depth appears feasible and a satisfactory sensitivity and accuracy for determining dose accumulated up to 1 year is obtainable. (UK)

53239 COMPARISON OF FILM BADGES AND THERMOLUMINESCENT DOSIMETERS. Crosby, E. H. (Guthrie Clinic, Sayre, Pa.). Health Phys.; 23: No. 3, 371-5(Sep 1972).

Ten individuals in 3 hospitals wore film badges and TLD monitors side by side on a monthly cycle for a period of 1 yr. Comparison of the exposures reported by both systems shows many inconsistencies, with one very noticeable trend. For those individuals working exclusively in diagnostic radiology, as opposed to radiotherapy or nuclear medicine, the agreement was generally poor. There were 15 instances out of a total of 120 where the exposure reported for the film badge was at least 10 times that reported for the TLD badge. All of these substantial discrepancies were for individuals working in diagnostic radiology. In view of the minimal energy dependence of lithium fluoride it is the author's opinion that the TLD reported exposures are nearer correct. Although both the film badge services involved have earned the National Sanitation Foundation seal of approval, there appears to be room for improvement in their interpretation of exposures to diagnostic x-rays. (auth) (UK)

53240 NATURAL FLUORITE IN THE DOSIMETRY OF THE MIXED FIELD OF GAMMA RAYS AND THERMAL NEUTRONS. Mishev, I. T.; Radicheva, M. A.; Levi, S. M. (Inst. of Physics, Sofia). Health Phys.; 23: No. 3, 367-9(Sep 1972).

The dependence of gamma sensitivity V_γ and of the sensitivity to thermal neutrons V_n of a homogeneous mixture of natural fluorite and LiF on the percentage content of ^6Li is investigated. It is found that at 10% ^6Li content in the mixture, $V_\gamma \approx 1/3\ V_{\gamma 0}$ and $V_n \approx 40\ V_\gamma$, where $V_{\gamma 0}$ is the gamma sensitivity of pure natural fluorite. (auth) (UK)

53241 DOSIMETRY SYSTEM FOR MEASURING INSTANTANEOUS DOSE AND LINEAR ENERGY TRANSFER SPECTRUM OF SPACE RADIATIONS. Schneider, Marion F.; Breen, Edward L. (to Secretary of the Air Force). U. S. Patent 3,678,275. 18 Jul 1972. Filed 15 Apr 1971.

A space radiation dosimetry system utilizing a portable tissue-equivalent ionization chamber mountable in a housing containing associated electronics and a linear energy transfer (LET) spectrometer with associated electronics is described. The LET spectrometer utilizes a telescope pair of solid state detectors in combination with amplifiers, a discretionary number of discriminator channels, logic circuits and counters to measure the linear energy transfer spectrum of high energy ionizing radiations. (auth)

53242 RADIOPHOTOLUMINESCENCE DOSIMETER WITH LOW γ-ENERGY DEPENDENCE. Kaes, H. H. (Fa. Ernst Leitz, Wetzlar, Ger.). Atomkernenergie; 20: No. 1, 75-8(1972). (In German).

The dosimetric properties of newly developed silver-activated radiophotoluminescence glasses on a fluoride base were investigated. With a suitable cation composition RPL glasses up to 75 Mol% fluoride content could be produced. Compared with a metaphosphate glass of the same activator concentration and cation composition, the fluoride glass possesses a comparable predose, higher sensitivity, lower γ-energy dependence, and slower fading. For sufficiently low silver concentration the dose reading is independent of the γ energy. The composition is free of toxic substances and stable against humidity. By consideration of all aspects, RPL dosimeters of fluoride base seem to be especially qualified for the use in integrating personnel dosimetry. (6 figures, 1 table) (auth)

53243 AUTOMATIC PRODUCTION OF ISO/SE CURVES. Kalnaes, Ole; Munk, Jens (Odense Sygehus, Denmark). Acta Radiol., Ther., Phys., Biol.; 11: No. 1, 90-6(Feb 1972).

The measuring equipment, the principles and the computer program for the automatic production of isodose curves for treatment planning at a 6-MeV linac are described. The measurements are carried out in a water phantom with an ionization chamber. This method necessitates measurements only of square fields and the computer plotted curves may be used directly in treatment planning. The accuracy obtainable is discussed. (auth)

53244 CONCEPTS W AND G USED IN RADIATION DOSIMETRY. COMMENTS ON CURRENT DEFINITIONS. Carlsson, Carl A. (Linkoepings Hoegskola, Sweden). Acta Radiol., Ther., Phys., Biol.; 11: No. 1, 106-12(Feb 1972).

The ICRU-definition of W, the average energy expended in a gas per ion pair formed, is applicable only when the charged particles are completely stopped by the gas or under charged particle equilibrium conditions. By changing the definition from $W = E/N$, where E stands for initial kinetic energy to $W = E_D/N$, where E_D means energy imparted, W can be used even when charged particle equilibrium does not exist, as in the case of cavity ionization dosimetry. A further advantage of the proposed definition is that W is closer related to the inverse of the quantity G used in radiation chemistry, where $G = M/E_D$ is defined as the average number, M, of changed molecules of one type per unit absorbed energy. Fundamental differences between W and G^{-1} are discussed. (auth)

53245 DOSIMETRIC PROPERTIES OF SOME THERMOLUMINESCENT SUBSTANCES. Szymczyk, Wieslawa; Polak, Bogumil; Byrski, Edward (Inst. of Oncology, Krakow). Nukleonika; 17: No. 3-4, 233-40(1972).

Lithium fluoride activated with Mg and Ti from two different batches and calcium fluoride activated with Mn were studied. The factors investigated were: Tl response vs dose, Tl response vs effective photon energy, and fading effect due to light exposure. (auth)

53246 HUMAN ENGINEERING STANDARDS FOR HEALTH PHYSICS INSTRUMENTATION. Erickson, G. L. (Douglas United Nuclear, Inc., Richland, Wash.). pp 257-70 of Radiation Protection Standards: Quo Vadis. Vol. II. Howell, Wallace P. (ed.). Richland, Wash.; Health Physics Society (1972).

From 6th annual topical symposium on radiation protection standards: quo vadis; Richland, Wash. (2 Nov 1971).

The pressing need for developing improved health physics instrumentation over the past 25 years has been greatly assisted by technological advances in instrument components. However, while measurement capability has improved significantly, the human engineering elements have not. Health physicists have complained loudly that instruments are bulky, too sensitive to environmental influences, hard to decontaminate and do not operate effectively under the adverse conditions they sometimes are subjected to. The instrument-developer, on-the-other-hand, responds, sometimes quietly, what do you want? If the questions and answers are properly pursued, the needed elements of human engineering emerge and are built into the instrument. If not, partly useful instruments may remain in service or be discarded while people "get along" with the "old stuff." This paper identifies some of the human engineering elements, points out how they are applied in radioactive environments and suggests that human engineering standards be developed. (4 figures) (auth)

53247 CRITIQUE OF STANDARD TESTING METHODS FOR PERSONNEL DOSIMETRIC DEVICES. Piltingsrud, H. V.; Love, P. E. (Radiological Health Lab., Wright-Patterson AFB, Ohio). pp 271-81 of Radiation Protection Standards: Quo Vadis. Vol. II. Howell, Wallace P. (ed.). Richland, Wash.; Health Physics Society (1972).

From 6th annual topical symposium on radiation protection standards: quo vadis; Richland, Wash. (2 Nov 1971).

Commonly recommended procedures for evaluating ionizing radiation responses of personnel radiation dosimetric devices or systems are usually centered around measuring responses of the devices with the incident radiation beam oriented to some favored surface of the dosimetric device. Included in this presentation are comments concerning the utility of this approach to dosimeter testing based on experience of the authors in evaluating angular and energy responses of several personnel dosimetric devices including several types of pocket ion chamber dosimeters, a film badge dosimeter system, thermoluminescent dosimeter (TLD) badge systems, and a neutron TLD badge system. (5 figures) (auth)

53248 MANUFACTURER'S VIEWS ON INSTRUMENT STANDARDS. Bellian, Joseph G. (Victoreen Instrument Div., Cleveland). pp 282-5 of Radiation Protection Standards: Quo Vadis. Vol. II. /Howell, Wallace P. (ed.). Richland, Wash.; Health Physics Society (1972).

From 6th annual topical symposium on radiation protection standards: quo vadis; Richland, Wash. (2 Nov 1971).

Instrument standards are needed by both manufacturers and users. There are definite advantages and some disadvantages to the user and manufacturer. Action should be taken to insure that standards do not create unnecessary problems. Proper procedures in developing standards and accurate methods of writing standards must be derived. In addition, realistic limits should be placed on organization with the authority to write standards. A proliferation of standards by several organizations will definitely reduce the effectiveness of all standards. In conclusion, what standards would the instrument manufacturers like to see written, if any? (auth)

53249 THERMOLUMINESCENT DOSIMETER (15 Sep 1961) (Engineering Materials). (Savannah River Operations Office (AEC), Aiken, S. C.). (CAPE-2239).

1 drawing.

A thermoluminescent (TL) dosimeter using two ^7LiF chips which monitors penetrating and nonpenetrating components of personnel radiation exposures is described. TL dosimeters are more accurate, less energy dependent, have a wider range of sensitivity and are simpler to use than film dosimeters. The TL badge consists of a pressed fiberboard insert embedded with two ^7Li chips, a folded paper (5.6 mg/cm^2), and a badge cover. The badge cover is the same as that used with film because the fiberboard and film packet are the same size. The folded paper

holds the ^{7}Li chips in the two $^{3}/_{16}$-in. dia recesses in the fiberboard and protects the chips from sunlight and contamination. One TLD chip is in the center of an open window and the other is behind an Al shield (460 mg/cm^2) on the badge cover. These positions give a means of differentiating between skin exposures and penetrating beta and gamma radiation. Extruded ^{6}LiF chips are used because they are insensitive to neutrons. A separate dosimeter is used for neutrons. (For details see TID-4100 Suppl. 72) (see also 26: 1288) (F.S.)

53250 MICROCALORIMETER (Jun 1971) (Engineering Materials). (New York Operation Office (AEC), N. Y.). (CAPE-2203).

3 drawings.

The tissue-equivalent absorbed-dose microcalorimeter is a primary standard for evaluating dosimeter-system's response to fast neutrons. It has a high degree of compactness and durability for transportation of the equipment to sources of $-\pi$ meson and ion beams of adequate intensity for calorimetric dosimetry. The microcalorimeter incorporates both active and passive thermal shields and is constructed of Shonka A-150 tissue-equivalent conducting plastic. (3 drawings) (For details see TID-4100 Suppl. 70) (see also 25: 55208) (F.S.)

Nuclear Spectroscopic Instrumentation

53251 (AREAEE-137) FAST NEUTRON SCINTILLATION SPECTROMETER WITH DOUBLE COMPENSATION CIRCUIT FOR GAMMA-RAY DISCRIMINATION. Megahid, R.; El-Razek, M. Abd; Makarious, A. S.; Kolevatoff, J.; Hamouda, I. (Atomic Energy Establishment, Cairo (Egypt). Reactor and Neutron Physics Dept.). 1972. 58p. Dep. NTIS (U. S. Sales Only).

The present work is concerned with the application of a single stilbene crystal spectrometer for measuring neutron spectra within the energy range of 0.5 to 15 MeV. The principles of operation of scintillation counters and their characteristics are briefly described. Consideration is given to the electronic method which is used for separating between voltage pulses resulted from the interaction of various particles of different ionization density with the scintillator. The method employed to transform the pulse spectrum into a neutron energy spectrum is discussed. A check-up on the correctness of the results obtained with the spectrometer is made by measuring continuous energy distributions of neutrons from the Pu–Be source and the UA–RR–1 reactor neutrons that passed through carbon, iron and water filters of different thickness. (auth)

53252 (CONF-720901-(Bks.1 and 2), pp 524-40) CRITICAL COMPARISON AND EVALUATION OF NEUTRON SPECTRUM UNFOLDING CODES: THE NEED TO KNOW. Meyer, W.; Mutone, G. A. (Kansas State Univ., Manhattan). 1972.

From Meeting on new developments in reactor physics and shielding calculations; Kiamesha Lake, NY. (12 Sep 1972).

With most on-line fast neutron spectrometry systems it is not possible to measure directly the energy spectrum of neutrons incident on the detector. The experimental data must be analyzed or "unfolded" to obtain the spectrum. To accomplish this special analysis, numerous analytical unfolding techniques and computer codes have been developed and applied. Unfortunately only very limited efforts have been made to compare and evaluate critically the many unfolding procedures, either in terms of the validity of the basic analytic procedures used or the value of the results obtained. Such a comparison and evaluation of the accuracy and the validity of error estimates of the various procedures are of utmost importance because if the experimental results of a neutron reflection or transmission experiment are to be used to infer nuclear cross sections values or if the measured data are to be used to evaluate a transport model, the accuracy of the experimental results must be known. (auth)

53253 (FRNC-TH-237) STUDY OF A CALIBRATION UNIT FOR γ-RAY SPECTROSCOPY. ANALYSIS OF PROBLEMS INVOLVED IN THE MEASUREMENT OF γ RAY ENERGIES BETWEEN 0 AND 10 MeV. Lapierre, Alain (Bordeaux Univ. (France)). 1972. 90p. (In French). Dep. NTIS (U.S. Sales Only).

Thesis.

The various problems involved in the calibration of a γ spectrometer in the energy range between 0 and 10 MeV are studied. The basic principles of the least square method are briefly developed. Possible applications of the method to a standard obtained from an (n,γ) radiative capture of thermal neutrons are envisaged. Above 2.5 MeV the best solution is shown to be a cubic. Below 2.5 MeV it is better not to use the whole curve and to use a truncated spectrum in view of obtaining a more valid equation of conversion. The device used for the acquisition of the standard spectra from an Am–Be neutron source is studied. The determination of the position of each standard peak is shown to be one of the most important problems in the least square method for calibration. (France)

53254 (NASA-TM-X-2440, pp 614-17) COMPTON SCATTER ATTENUATION GAMMA-RAY SPECTROMETER. Austin, W. E. (General Electric Co., Philadelphia). Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

A Compton scatter attenuation gamma ray spectrometer conceptual design is discussed for performing gamma spectral measurements in monodirectional gamma fields from 10^{2}R hr^{-1} to 10^{6}R hr^{-1}. Selectable Compton targets are used to scatter gamma photons onto an otherwise heavily shielded detector with changeable scattering efficiencies such that the count rate is maintained between 500 and 10^{4} sec^{-1}. Use of two sum-Compton coincident detectors, one for energies up to 1.5 MeV and the other for 600 keV to 10 MeV, will allow good peak to tail pulse height ratios to be obtained over the entire spectrum and reduces the neutron recoil background rate. (auth)

53255 (NASA-TM-X-2440, pp 714-22) IDENTIFICATION AND CONTROL OF SPACECRAFT RADIATION SOURCES OF INTERFERENCE TO X-RAY AND GAMMA-RAY EXPERIMENTS. Metzger, Albert E. (California Inst. of Tech., Pasadena); Trombka, Jacob I. Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

Apollo 15 and 16 will carry instruments for the purpose of measuring x-ray and gamma ray fluxes from the lunar surface and in cis-lunar space. The intensity levels expected are low over most of the energy range of interest, requiring that background contributions be minimized. The radiation sources on Apollo have been determined and their interference with these instruments evaluated. The results have been used as a basis for dealing with this problem and for recommendations applicable to future manned and unmanned missions. (auth)

53256 (NASA-TM-X-2440, pp 744-6) Ge(Li) DATA REDUCTION USING SMALL COMPUTERS. McDermott, W. E. (McClellam AFB, Sacramento, Calif.). Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

The use of a PDP 8/I computer for Ge(Li) spectra analysis for analyzing mixtures of radioisotopes is briefly described. The computer is interfaced to the analyzer memory in which the data are stored. A flow chart of a typical peak location and analysis program is shown. (W.H.K.)

53257 (RT/FI-(72)14) AUTOMATIC PEAK IDENTIFICATION IN THE ANALYSIS OF GAMMA-RAY SPECTRA OBTAINED WITH Ge(Li) DETECTORS. Giannini, M.; Oliva, P. R.; Ramorino, M. C. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 14 Apr 1972. 79p. Dep. NTIS (U. S. Sales Only).

A computer code for full automatic analysis of γ-ray spectra obtained with Ge(Li) detectors is described. The significant peaks in the spectrum are detected by observing the behavior of the second derivative function after random variations in count rate have been minimized by the application of a smoothing filter function. Particular care is taken in the recognition of weak or adjacent peaks, even in the presence of high statistical fluctuations. This is achieved by means of a new check procedure working during the fit routine. The possibility of trying a new fit every time some spurious peak prevents a good fit from being reached is also introduced; it results in a considerable improvement in the elimination of pseudopeaks. Applications to experimental and simulated spectra are shown. (16 figures, 8 tables) (auth)

53258 (SC-DR-720630) PASSIVE CALORIMETER FOR PULSED ELECTRON BEAM ENERGY MEASUREMENT. Heckman, R. C.; Stephens, H. P.; Donaldson, A. B. (Sandia Labs., Albuquerque, N. Mex.). Sep 1972. 27p. Dep. NTIS.

A passive calorimeter for diagnostics of high energy pulsed electron beams is described. It consists of a thin rectangular sheet which is irradiated by the electron beam in a central region. The generated heat diffuses outwardly to the ends so that each position experiences a temperature maximum. Thin strips of materials which melt at various temperatures are coated on the surface to provide a record of the temperature maxima of the calorimeters. The corresponding heat diffusion problem is analyzed and used with the experimental results to calculate the initial temperature of the irradiated region, and thus the dose. The calorimeter absorbs only a small fraction of the beam energy and is therefore useful for making dose measurements simultaneously with experiments. (auth)

53259 MAGNETIC-PRISM β SPECTROMETERS. Peregud, B. P. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Tech. Phys. (Engl. Transl.); 17: No. 3, 365-84(Sep 1972).

Translated from Zh. Tekh. Fiz.; 42: No. 3, 457-83(Mar 1972).

The theory of the magnetic-prism β spectrometer is reviewed, including the electron-optical scheme, ray paths in the paraxial approximation, dispersion, and relative aperture. The resolution and aberrations of electron-optical devices are discussed; these include adjustment errors, lens aberrations, and aberrations of the magnetic prism. Methods for designing electron-optical devices, such as magnetic lenses and magnetic prisms, are described; and the spectroscopic properties of the instruments are summarized. (15 figures, 2 tables, 52 references) (R.W.R.)

53260 SYSTEM FOR TIME OF 50 m FLIGHT ANALYSIS AND CHARACTERISTICS OF SHORT PULSE BEAM. Kawamura, Nobuaki (Tohoku Univ., Sendai); Saito, Hajime; Tsubota, Hiroaki; Mutsuro, Naoshi. Kakuriken Kenkyu Hokoku; 4: No. 1, 48-52 (Sep 1971). (In Japanese).

A neutron detection system was installed at a distance of 50 m in a time-of-flight system of 125 m. An absorption spectrum of photoneutrons from ^{12}C was taken for the purpose of calibration. Large time-dependent background was found on low-channel side. The source of the background was found to be gamma-rays scattered by a lead target. The attenuation of the gamma-rays by absorbers was small. It is difficult to measure neutrons above 10 MeV with the present experimental arrangement. Troubles were found in a pulse beam system. Multiple short beams occurred for one trigger cycle; and so-called grass, spill other than the main short pulses, was seen. Improvement of the system was performed, and the troubles were reduced. Temporary shielding will be set around the flight tube in the near future. (Japan)

53261 SPENT FUEL MONITOR (28 Sep 1970) (Engineering Materials). (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). (CAPE-2238).

3 drawings.

A system consisting of a low-resolution NaI detector with a stabilizer and five single-channel analyzers provides sufficient data to determine the age of the spent fuel (time in days since the irradiated fuel was discharged from a reactor). Count data from the single-channel analyzers are processed manually to determine the age of the fuel. The manual process involves taking the ratio of specific scaler data and determining the age of the fuel which corresponds to the measured ratio from a graph. (3 drawings) (For details see TID-4100 Suppl. 72) (see also 25: 39734 and 26: 2266) (F.S.)

53262 REFERENCE PULSER (23 Jun 1971) (Engineering Materials). (California Univ., Livermore. Lawrence Radiation Lab.). (CAPE-2210).

21 drawings.

A transistorized pulser which features a highly-stable dual-transistor pulse generation network is described. The temperature stability of the pulser output is $\leq \pm 5$ ppM/°C from 10 to 50°C. Long term stability is approximately $\pm .02$ channels/day. The pulser is used to improve the performance and reliability of the bio-medical γ-ray spectrometers which use high-resolution Ge(Li) detectors. The spectrometers analyze γ-emitting samples originating from biological research and environmental sampling programs. The pulser provides high-stability output pulses which, when applied to the spectrometer preamplifier, produce two-reference peaks necessary for spectrum stabilization. (21 drawings) (For details see TID-4100 Suppl. 70) (see also 26: 9354) (F.S.)

53263 TWO DECADES OF RESEARCH ON RADIOACTIVITY. THE IMPACT OF ADVANCES IN INSTRUMENTATION. Hamilton, J. H. (Vanderbilt Univ., Nashville); Manthuruthil, J. C.; Rasmussen, J. O. Nucl. Instrum. Methods; 103: No. 2, 277-90(1972).

A review is made of the impact that sophisticated new instrumentation and detectors are having on the quantity and quality of data acquired from radioactivity studies. Such studies are providing much new information to test details of current nuclear models and offer challenges to further theoretical development. The new frontiers, in-beam and on-line spectroscopy, open up many areas for research. (9 figures, 50 references) (auth)

53264 COMPACT ELECTRON SPECTROMETER FOR IN-BEAM MEASUREMENTS OF INTERNAL CONVERSION COEFFICIENTS. Cambi, A.; Fazzini, T. F.; Giannatiempo, A.; Maurenzig, P. R. (Univ., Florence). Nucl. Instrum. Methods; 103: No. 2, 331-5(1972).

A compact magnetic spectrometer for measuring electron conversion coefficients is described. A very efficient method to subtract the activation background, based on a pulsed beam-coincidence technique, is also presented and discussed. The chosen angle of detection for the electrons avoids the ambiguities present in previous methods and allows straightforward assignments of transition multipolarities in a number of specified cases. (3 figures) (auth)

53265 THIN FILM OF ORGANIC FLUORESCENT MATERIALS FOR SIMPLE DETECTION OF ALPHA RAYS. Koike, Y.; Handa, M.; Yamamoto, K. (Tokyo Metropolitan Isotope Research Center). Nucl. Instrum. Methods; 103: No. 2, 249-52(1972).

Vacuum-deposited and sprayed thin films of organic fluorescent materials are useful as detectors for simple detection of alpha particles. Films of 1,12-benzperylene and sodium salicylate showed excellent pulse height properties for alpha rays at room temperature in air. The films of fluorescent solutes used in the liquid scintillation counting also showed excellent pulse height properties. The full widths at half maximum of the films for alpha spectra are between 8 and 35% and of the same order as that of thin plastic scintillator used as a standard scintillator. The films of these materials are insensitive to high-energy beta and gamma rays because the thickness of these films is too thin to detect these rays. (3 figures, 1 table) (auth)

High Energy Physics Instrumentation

53266 (BNL-17020) PORCUPINE. Kirk, T. W. (Brookhaven National Lab., Upton, N. Y.). [nd]. 18p. Dep. NTIS.

A new 4π counter for detecting reaction products from high-multiplicity reactions involving perhaps 20 or more final-state particles is described. It consists of about 47,000 proportional wire counters with their active volumes aligned so that the multiplying wire electrodes all point at the interaction region (hence the name). Each counter thereby becomes its own charged-particle detector, and the large total number of elements insures (at least to first order) that each reaction product will trigger a unique detector. One thus gets a complete spatial picture of each event with no further analysis or reconstruction necessary. No information is known about the individual charged-particle momenta or the neutral-particle multiplicities, however, the Porcupine should be combined with some sort of segmented calorimeter like the Impactometer. The economic justification for this detector is discussed. The geometry of the detector array, as well as electronics and mechanical details, is also described. (5 figures) (R.W.R.)

53267 (BNL-17064) FOR THE MEASUREMENT OF MULTIPLICITIES: THE "MULTIMETER". Nygren, David R. (Brookhaven National Lab., Upton, N. Y.). [nd]. 8p. Dep. NTIS.

A 4π counter for interactions with high multiplicities is described. The basic idea of the multimeter is to use multiwire proportional chambers (MWPC's) in an $x-y$ configuration and to record not only which wires are hit, but also to measure where along the wire the signal is generated. The electronics required in the fabrication of such a detector is discussed in some detail. If gammas and other neutrals are of interest, converters and other MWPC's can be conveniently added. (1 figure) (R.W.R.)

53268 (BNL-17066) CONCEPTUAL DESIGN OF A HYBRID DETECTOR FOR ELECTRON PHYSICS AT ISABELLE AND PEP: SOLENOID + QUANTAMETER + HADROMETER (CALORIMETER). Stevenson, M. L. (Brookhaven National Lab., Upton, N. Y.). 31 Jul 1972. 17p. Dep. NTIS.

An electron detector for colliding e-p beams at ISABELLE and PEP is described. The size, field strength, and measurement accuracy of the superconducting solenoid are discussed. The design and performance of the complementing quantameter are then described. Reasons for adding a hadrometer to the above combination are considered. (10 figures) (R.W.R.)

53269 (BNL-17070) PROGRAM FOR DEVELOPMENT OF A LIQUID ARGON CALORIMETER. Willis, William J. (Brookhaven National Lab., Upton, N. Y.). 21 Jul 1972. 4p. Dep. NTIS.

A specific program is outlined for the evaluation of liquid argon as a scintillator and the development of large total absorption counters based on its use. (auth)

53270 (BNL-17071) CALORIMETERS FOR ISABELLE. Willis, William J. (Brookhaven National Lab., Upton, N. Y.). 21 Jul 1972. 14p. Dep. NTIS.

A review is given of the available types of total absorption counters for hadrons. The design and operating features are described, with emphasis on the factors which limit energy resolution. (auth)

53271 (JINR-P13-6522) SYSTEM OF WIRE SPARK CHAMBERS WITH FERRITE CORE MEMORY. Azhgirei, L. S.; Asanov, V. V.; Budkin, L. V.; Bychkov, V. A.; Kuznetsov, A. S.; Stoletov, G. D.; Filozov, A. F. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1972. 18p. (In Russian). Dep. NTIS (U. S. Sales Only).

A system of wire spark chambers with ferrite core memory is described. The data are presented on the chamber construction and on the mode of information readout. The efficiency and memory time of the chambers with various gas filling are studied.

It is shown that, under certain conditions, the accuracy of the detection of charged particle coordinates reaches $\approx \pm 1/4$ from the distance between the wires. (auth)

52272 (JINR–P13–6541) ON POSSIBLE MEASURING HIGH-ENERGY ELECTRON ENERGY BY IONIZATION DETECTORS OF TOTAL ABSORPTION ON THE BASIS OF CONDENSED XENON. Kulikov, Yu. V.; Ryabtsov, V. D.; Silaev, E. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1972. 14p. (In Russian). Dep. NTIS (U. S. Sales Only).

The problems concerning the fabrication of a total-absorption ionization electron-pulsed detector for measuring electron and high-energy gamma-quanta energies on the basis of condensed xenon are considered. (5 figures) (auth)

52273 (LA–4968) BIFILAR HELICAL MULTIWIRE PROPORTIONAL CHAMBER FOR POSITION SENSITIVE DETECTION OF MINIMUM IONIZING PARTICLES. Lee, D. M.; Sobottka, S. E.; Thiessen, H. A. (Los Alamos Scientific Lab., N. Mex.). Aug 1972. Contract W-7405-eng-36. 11p. Dep. NTIS.

A new type of multiwire proportional chamber with a helical cathode for delay-line readout was developed and studied in detail. It gives cathode delay-line pulses nearly as large as the anode pulses; hence, it is well-suited for minimum ionizing particles. Measurements on such a chamber yielded spatial resolution better than 0.33 mm fwhm for ^{90}Sr β particles, a resolving time less than 30 ns, and maximum counting rate greater than 2 MHz. The most probable pulse height induced on the delay line by minimum ionizing particles in this chamber is approximately 8 mV. (15 figures) (auth)

52274 (RHEL/R–241) TRACK DETECTION PROGRAM FOR A HOUGH POWELL DEVICE. Hallowell, P. J. (Rutherford High Energy Lab., Chilton (England)). May 1972. 15p. Dep. NTIS (U. S. Sales Only). UK 20 pence.

A track detection program, designed to reduce data from the HPD installations at Rutherford High Energy Laboratory for analysis of bubble chamber photographs is described. The method employs a stringing technique to produce precision master points for input to the R.H.E.L. Geometry Program. (auth)

52275 (RPP/H–101) COMPACT EHT POWER SUPPLY FOR USE WITH HIGH PULSE RATE SPARK CHAMBERS. Connolly, J. F.; Gilby, A. S. (Rutherford High Energy Lab., Chilton (England)). Jun 1972. 21p. Dep. NTIS (U. S. Sales Only).

High pulse rate spark chambers require EHT power supplies capable of charging up the capacitive load of the pulser units employed in such systems. Typical values for this capacitive load are in the range 10 to 50 nF which for pulse rates of 10 per second and above results in a high current demand from the EHT supply. A compact EHT capacitor charging unit, developed at the Rutherford High Energy Laboratory for use in such applications, is described. (auth)

52276 IZMERENIE RADIATSII V KOSMOSE. (Measurement of Radiation in Space). Gal'perin, Yu. I.; Gorn, L. S.; Khazanov, B. I. Moscow; Atomizdat (1972). 344p.

Fundamental problems in the measurement of ionizing radiation in space near the earth and the detection of fluxes of electrons, neutrons, heavy charged particles up to 1 GeV and electromagnetic radiation are examined. Some block diagrams and circuitry of measuring equipment are discussed. (446 references) (K.S.W.)

52277 TRANSITION COUNTER. Wang, C. L.; Dell, G. F. Jr.; Uto, H.; Yuan, Luke C. L. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Lett.; 29: No. 12, 814-17(18 Sep 1972).

A new type of counter based on the transition radiation from ultrarelativistic charged particles is reported. The efficiency of the "transition counter" depends almost linearly on the Lorentz factor of the particle in the energy region covered and is over 80% for 2-GeV electrons. Particles heavier than electrons in a 2-GeV unseparated beam are effectively rejected. A possible application of the counter at multihundred-GeV accelerators is discussed. (auth)

52278 ULTRA-LINEAR 16-BIT DIGITAL-TO-ANALOG CONVERTER (13 Feb 1970) (Engineering Materials). Chicago Operation Office (AEC), Ill. Reactor Engineering Div.). (CAPE–2192).

29 drawings.

The 16-bit binary digital-to-analog converter is used for the deflection yokes of the Dolly CRT flying-spot scanning system in order to provide a high-resolution raster from which measurements are made digitally. The digital input is converted directly to binary-weighted currents. For each bit there is a constant current source and a current switch. The current sources are weighted according to their digital-bit value and current switches deliver the current either to one half of the yoke or the other half. Voltage across the current-determining resistor of each current source is identical and constant. The resistors are of sufficient accuracy that no trimming is necessary. In this method of conversion, binary-weighted constant current sources are switched into a summing junction, the yoke of the CRT. A conversion linearity of 0.00025% and a stability of 0.0004%/hr were measured for a full scale current of one ampere. For long-term linearity, good thermal stability, and minimal maintenance, the converter requires little or no adjustment. (29 drawings) (For details see TID-4100 Suppl. 70) (see also 24: 7687) (F.S.)

52279 ANNIHILATION SPECTROMETER FOR INVESTIGATION OF HEAVY MESON SPECTRA. Alspector, J. (Rutgers–The State Univ., New Brunswick, N. J.); Cohen, K.; Harrison, C.; (and others). Nucl. Instrum. Methods; 103: No. 2, 239-43(1972).

The "Rutgers Annihilation Spectrometer" (RAS) measures cross sections for antiproton annihilations as a function of the $\bar{p}p$ mass, final-state multiplicities, and degree of nonperipheralism, with a resolution of ±5 MeV and typical statistics of 10^6 events per mass bin 5 MeV wide. The nonannihilation events are suppressed by anticoincidence with the events in which charged particles are emitted within the forward cones defined by the lab polar angles 2½°, 5°, 10°, and 20° (4 "degrees of nonperipheralism"); in this way single-meson exchange mechanisms, which are nonresonant and highly peripheral, are eliminated. Measurements are done at 7 incident momenta simultaneously. Scintillation counters are the only detectors used. On-line data acquisition is accomplished by a hard-wired electronic processor ("MEGAHPOL") capable of sorting data on 100,000 incident antiprotons per second. (7 figures) (auth)

52280 VERSATILE, HIGH-RESOLUTION PARTICLE IDENTIFIER: THEORY. Greiner, D. E. (Univ. of California, Berkeley). Nucl. Instrum. Methods; 103: No. 2, 291-308(1972).

A method of measurement and analysis is presented which makes maximum use of the dependence of energy loss dE/dx upon range to identify isotopically particles which stop in an identifier consisting of several thick solid state detectors. Theoretical identification efficiency, mass resolution, charge resolution, and energy resolution are determined. (22 figures) (auth)

52281 HELIUM-RECOIL SPECTROMETER. Dahlgren, S. (CERN, Geneva); Herz, A. J.; Kullander, S.; (and others). Nucl. Instrum. Methods; 103: No. 2, 309-23(1972).

The instrument described is intended for the detection and measurement of α particles from coherent interactions of high-energy particles with ^{4}He nuclei. It allows the determination of the magnitude and the direction of the momenta of the helium recoils from interactions in a pressurized gas target. The measurements are carried out with spark chambers and scintillation counters. Recoils emitted at angles greater than 65° with respect to the beam direction are accepted, and the range of azimuth angles covered is 294°. (16 figures) (auth)

52282 MUON IDENTIFICATION USING MULTIWIRE PROPORTIONAL CHAMBERS. Harris, F. A. (Univ. of Hawaii, Honolulu); Parker, S. I.; Peterson, V. Z.; Yount, D. E.; Stevenson, M. L. Nucl. Instrum. Methods; 103: No. 2, 345-55(1972).

Test data are summarized for a muon identifier consisting of iron absorber plates followed by multiwire proportional chambers. Because of the penetrating secondaries that result from hadronic interactions, conventional muon identifiers lacking spatial resolution require many collision lengths to attenuate the hadron flux and thus separate incident hadrons from muons. By using multiwire proportional chambers, hadronic interactions can be detected well before the subsequent hadron cascades have been fully absorbed. This permits a substantial reduction in absorber thickness, and is important in applications in which the muons originate in a large volume or in which they are to be identified over a large area or large solid angle. A typical result from these tests is that at 3 GeV/c a single multiwire proportional chamber, following only 50 cm of iron, can reject pions with 96 ± 1% efficiency while accepting 96% of the incident muons. An important advantage of this technique is that the performance is expected to be rather independent of energy above a few GeV. (9 figures, 2 tables) (auth)

52283 GENERAL PROPERTIES OF THE CURRENT-LIMITED SPARK CHAMBER. Stubbs, R. J.; Breare, J. M. (Univ. of Durham, Eng.). Nucl. Instrum. Methods; 103: No. 2, 389-93(1972).

The operating characteristics of sealed, current-limited spark chambers filled with 98% neon, 2% helium were studied and found to be similar to those of the more conventional chambers in many respects. However, some properties of the chambers show anomalous effects, which are suggested as being due to an internal electric field caused by the discharges. (5 figures, 1 table) (auth)

52284 2π STERADIAN MAGNETIC SPECTROMETER. McReynolds, J. F.; Newton, D.; Wenzel, W. A. (Univ. of Cali-

fornia, Berkeley). Nucl. Instrum. Methods; 103: No. 2, 397-403(1972).

The magnetic properties of a 2π-steradian spectrometer used in the study of K^+ decays at rest are described. Charged particles emitted from the axis of a cylindrically symmetric field are focused back to the axis after one nearly circular orbit. The field was shaped to give small spherical aberration and a relatively small overall chromatic aberration for momenta in a ten percent momentum range. Other possible experiments are described. (5 figures) (auth)

52285 CORRECTION OF LIGHT ATTENUATION IN LARGE SHOWER COUNTERS. Lakin, W. L.; Petraske, E. W.; Toner, W. T. (Stanford Univ., Calif.). Nucl. Instrum. Methods; 103: No. 2, 431-3(1972).

A simple procedure, based on elementary shower theory, was devised to compensate for attenuation losses over the surface of large sandwich-type shower counters. It uses tapered lead sheets in place of the usual flat plates, and is capable of compensating for attenuation of as much as a factor of two. (2 figures, 1 table) (auth)

Radiometric Instruments

52286 (N-71-37956) DESIGN OF A RADIOACTIVE NON-CONTACT ENCODER. Barnett, M. B. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Aug 1971. 20p. (NASA-TM-X-65715; X-721-71-349). NTIS.

A non-contact encoder device for the detection of radioactive sources is described. The device consists of: (1) encoder assembly; (2) radioactive source of Am-241 and (3) a semiconductor silicon diode detector. The theory of operations, performance, advantages, disadvantages, and applications are discussed. (STAR)

52287 EVALUATION OF A CROSS SECTION IONIZATION DETECTOR SUITABLE FOR MINE AIR ANALYSIS. Pursall, B. R.; Dugar, A. C. (Univ. of Sheffield, Eng.). J. Phys., E (London): 5: No. 9, 862-8(Sep 1972).

Detection of the permanent gases in mine air using the cross section ionization detection system is described. A dual chamber ionization cross section detector, with a tritium source, was designed and the results of analysis compared with the results obtained from an argon detector, with a ^{90}Sr source, in its cross section mode of operation. The performance characteristics of both the detectors suggest that the ionization cross section method is precise and reliable and capable of detecting a minute quantity of the test gas in the parts per million range or less. The performance characteristics were compared with those of other reported designs, but using carbon dioxide as the test gas instead of propane. The performance was measured by the exponential decay method of calibration and the construction of a dilution chamber containing a magnetically driven stirrer is described. It is suggested that a series of parallel column method of a balanced pair cross section detector system would reduce the random noise level and improve its performance characteristics still further. (auth)

52288 RADIOIZOTOPNYE RELE. IZDANIE ETOROE, PERERABOTANNOE I DOPOLNENNOE. (Radioisotopic Relays. Second Edition, Revised and Expanded). Vasil'ev, A. G.; Klempner, K. S. Moscow; Izdatel'stvo Mashinostroenie (1971). 176p.

Relays which utilize nuclear radiation sources are discussed, intensimetric and electrical aspects are examined. Considerable attention is given to reliability criteria for operating relays. Fundamental parameters of radioisotopic relays, their experimental determination, and the engineering design of relays are discussed. (104 references) (K.S.W.)

Radiation Effects on Instrument Components, Instruments, and Electronic Systems

Refer also to abstracts 53223, 53307–53309, 53338, and 53927.

52289 (NASA-TM-X-2440, pp 481-6) HARDENING ELECTRONIC DEVICES AGAINST VERY-HIGH-TOTAL-DOSE RADIATION ENVIRONMENTS. Buchanan, B.; Shedd, W.; Roosild, S.; Dolan, R. (Air Force Cambridge Research Labs., Bedford, Mass.). Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

The possibilities and limitations of hardening silicon semiconductor devices to the high neutron and gamma radiation levels (greater than 10^{16} neutrons/cm^2 (1 MeV eq.) and greater than 10^8 rads (Si)) required for the NERVA nuclear engine development are discussed. A comparison is made of the high dose neutron and gamma hardening potential of bipolar, metal insulator semiconductor (MIS), and junction field effect transistors (JFET). Experimental data are presented on device degradation for the high neutron and gamma doses. Previous data and comparisons indicate that the JFET is much more immune to the combined neutron displacement and gamma ionizing effects than other transistor types. Presently, hardened JFET's degrade about 50% at 10^{16} neutrons/cm^2. Theoretically they can be improved, but the resulting hardened JFET's have low breakdown voltages (less than 20 volts). Experimental evidence (5 volt threshold shift at 10^8 rads) is also presented, which indicates that p channel MOS devices, made by Hughes Aircraft may be able to meet the requirements. Electrical characteristics compromises caused by device hardening and the ability to satisfy requirements on a practical reliable basis are discussed. (auth)

52290 (NASA-TM-X-2440, pp 577-83) SOLAR CELL RADIATION RESPONSE NEAR THE INTERFACE OF DIFFERENT-ATOMIC-NUMBER MATERIALS. Burke, E. A.; Cappelli, J. R.; Lowe, L. F.; Wall, J. A. (Air Force Cambridge Research Labs., Bedford, Mass.). Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

The response of Co-60 irradiated N/P silicon solar cells was measured as a function of the atomic number of the medium adjacent to the cell and the direction of the gamma ray beam. The interpositioning of various thicknesses of aluminum between the adjacent material and the cell had the effect of moving the cell to various locations in an approximate monatomic numbered medium. Using this technique the solar cell response was determined at various distances from the interface for gold and beryllium. The results were compared with predictions based upon ionization chamber measurements of dose perturbations in aluminum and found to agree within five percent. Ionization chamber data were then used to estimate the influence of various base contact materials. The directional effect is most noticeable for gold contacts leading to a response when the beam enters the cell face which is 40% greater than for the opposite direction. The situation is reversed for beryllium which produces a response which is 17% greater when the beam enters through the base than for the reversed direction. (auth)

52291 (NASA-TM-X-2440, pp 708-13) RESPONSE OF A 300-μ SILICON DETECTOR TO MONOENERGETIC NEUTRONS DETERMINED BY THE USE OF THE MONTE CARLO TECHNIQUE. Taherzadeh, M.; Anno, G. (California Inst. of Tech., Pasadena). Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

The response of a 300 μ thick silicon detector to an incident monoenergetic neutron beam is evaluated by the Monte Carlo method for the cases of both a shielded and a bare detector. The result of the Monte Carlo calculation, using elastic, inelastic and absorption reactions indicates that the response of the silicon detector to neutrons is basically due to the elastic scattering. In addition, the gamma rays generated in the shield of the detector will result in a response which is 3 or 4 orders of magnitude smaller than response to incident photons. The response of a bare silicon detector is calculated for neutron energies up to 6 MeV and bias energies from 50 to 250 keV. It is found that the maximum response for a 300 μ thick silicon detector is less than 4×10^{-3} c/n within this selected neutron and bias energy range. When the pulse height defect is introduced in the calculation, the results at low energy are reduced. The study was undertaken to evaluate the effects of radiation from radioisotope thermoelectric generators on detectors in space vehicles. (auth)

52292 (NASA-TM-X-2440, pp 729-34) RADIATION EFFECTS ON SCIENCE INSTRUMENTS IN GRAND TOUR-TYPE MISSIONS. Parker, Richard H. (California Inst. of Tech., Pasadena). Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

The extent of the radiation effects problem is delineated, along with the status of protective designs for 15 representative science instruments. Designs for protecting science instruments from radiation damage are discussed for the various instruments to be employed in the Grand Tour type missions. A literature search effort has been undertaken to collect science instrument components damage/interference effects data on the various sensitive components such as Si detectors, vidicon tubes, etc. A small experimental effort is underway to provide verification of the radiation effects predictions. The various experimenters whose instru-

ments are used as models have made available some of their own radiation effects experience for this study. (auth)

52293 (NASA-TM-X-2440, pp 735-43) RADIATION NOISE IN A HIGH-SENSITIVITY STAR SENSOR. Parkinson, J. B.; Gordon, E. (Aerojet ElectroSystems Co., Azusa, Calif.). Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

An extremely accurate attitude determination has been developed by Aerojet Electro Systems Company for space applications. This system uses a high sensitivity star sensor in which the photomultiplier tube is subject to noise generated by space radiations. The space radiation induced noise arises from trapped electrons, solar protons and other ionizing radiations, as well as from dim star background. The individual noise components have been successfully simulated for pre-flight evaluation of the star sensor performance. The steady trapped electron and the intermittent solar proton environments for a high altitude orbit are related to solar activity. The solar activity and hence the electron and proton environments are predicted through the end of the twentieth century. The available data for the response of the phototube to proton, electron, gamma ray, and bremsstrahlung radiations are reviewed and new experimental data are presented. Prompt and delayed pulses from the faceplate/photocathode and contributions from the dynodes are isolated, and pulse height distributions are given for each. The predicted electron and proton environments are then combined with phototube response. The average noise due to the relatively steady electron environment is of the order of 10^4 pulses per second compared with 2×10^5 pulses per second for the signal from a single 4.6 magnitude star. For a typical worst solar proton event, the noise will be 10^5 to 10^6 pulses per second, which is comparable to the signal from a nominal 4.6 magnitude star. This noise will typically last about one day. The model for the dim star background averages 3×10^4 pulses per second but varies widely. A simulation was developed which represents the characteristics of the effect of radiations on the star sensor, including the non-stationarity of the backgrounds. (auth)

52294 (NASA-TM-X-2440, pp 866-72) PROGRAM AT JPL TO INVESTIGATE THE NUCLEAR INTERACTION OF RTGs WITH SCIENTIFIC INSTRUMENTS ON DEEP SPACE PROBES. Truscello, Vincent (California Inst. of Tech., Pasadena). Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

A major concern in the integration of a radioisotope thermoelectric generator (RTG) with a spacecraft designed to explore the outer planets is the effect of the emitted radiation on the normal operation of scientific instruments. The program presently being conducted at the Jet Propulsion Laboratory to evaluate these effects is discussed. The problem is being approached in both an analytical and experimental manner. The necessary techniques and tools have been developed to allow accurate calculation of the neutron and gamma spectrum emanating from the RTG. The specific sources of radiation have been identified and quantified. Monte Carlo techniques are then employed to perform the nuclear transport calculations. The results of these studies are presented. An extensive experimental program has been initiated to measure the response of a number of scientific components to the nuclear radiation. Such devices as Geiger-Muller tubes, solid-state detectors, and electron multipliers have been identified as being most probable for use on these missions and extremely sensitive to gamma radiation. Experiments on these devices are being conducted in the JPL radiation laboratory. The capabilities of this laboratory are discussed as well as the results of some of the experiments. The technique used to measure the response of instruments is to irradiate them with monoenergetic radiation sources. The energy range of interest is between 275 and 2800 keV. Approximately seven isotopes have been selected which provide emissions in this range. Analytical techniques have been developed which fold the measured energy response of the instrument with the calculated energy spectrum emitted by the RTG. Shielding studies are then performed to determine the thickness of shield required to reduce the spurious count level of the instrument to an acceptable level. The final design must be qualified by irradiating the instrument with the polyenergetic spectrum emitted by the ^{238}Pu fuel capsule. Since actual fuel capsules are not generally available and since the spectrum from a generator will change with time due to aging of the fuel (spectrum actually becomes harder and more intense due to buildup of the daughter products of the impurity ^{236}Pu) it becomes more practical to use simulated sources. (auth)

Miscellaneous Instruments and Components

Refer also to abstracts 52957, 53421, 53648, 54971, 54972, 54975, 55122, and 55448.

52295 (AREAEE-132) TRANSISTORIZED PULSE GENERATOR FOR TESTING NUCLEAR COUNTING EQUIPMENT. Hanna, Nabil N. (Atomic Energy Establishment, Cairo (Egypt). Engineering and Scientific Instruments Dept.). 1972. 21p. Dep. NTIS (U. S. Sales Only).

A multirange pulse generator for supplying positive and negative rectangular output pulses of adjustable amplitude over the range 0 to 10 V is described. The repetition rate is continuously adjustable from 10 Hz to 100 kHz in 4 ranges. Pulse duration is variable from 1 μsec to 10 msec in 4 ranges with rise and fall times of less than 40 nsec. The output impedance is 50 ohms and the generator can be operated at duty cycles of up to 0.8. The generator can be triggered from the positive slope of external synchronizing signals whose frequency may range from D.C. to 500 kHz to deliver delayed rectangular pulses of the desired height and duration. The minimum triggering level can be adjusted in the range 0 to 10 V. The delay is continuously variable from 0 to 10 msec in 4 ranges. The generator is fully transistorized and of simple design. The relatively high stability of pulse parameters makes it particularly useful for testing nuclear counting equipment. (auth)

52296 (CEA-N-1539) STUDY AND DEVELOPMENT OF TWO HIGH PERFORMANCE SPECTROMETER MAGNETS. de Sereville, Bernard; Ohayon, Maurice; Penicaud, Jean-Pierre; Turck, Bernard (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Jun 1972. 71p. (In French). Dep. NTIS (U. S. Sales Only).

Two high-performance spectrometer magnets (window frame type) were constructed. Detailed analysis of the possible causes of error in the measurement of the magnetic field was used to determine the precision with which the equipment had to be constructed and the accuracy with which the measurements had to be made. The two-dimensional program MARE-C was used to investigate the magnetic field and to determine its effect on the coil structure. The study of the fringing magnetic field was performed with the same program, a similar aperture magnet being used. The radius of the magnetic fringing field was determined with an accuracy better than 1%. The forces acting on the coils and the important aspects concerning their construction are presented. The principal experimental results are given. (France)

52297 (CEA-N-1549) CAMAC SYSTEM: PRACTICAL INFORMATION FOR A COMPUTERIZED TREATMENT. Gallice, Pierre; Robin, Georges (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). May 1972. 20p. (In French). Dep. NTIS (U. S. Sales Only).

The CAMAC system is an international system, defined by the Comite ESONE (EURATOM), which can be used in conjunction with several types of computers. The interconnection system between the digital nuclear physics equipment and a computer is described. Complementary information is given on the adapting of a particular language to the system with the normal programming envisaged. (France)

52298 (COO-3058-9) ECONOMICAL SCALER DRIVER. Krycuk, G.; Tatarczuk, J. R. (Rensselaer Polytechnic Inst., Troy, N. Y. Dept. of Nuclear Science). 1972. Contract AT-(11-1)-3058. 6p. Dep. NTIS.

A scaler driver is described which permits the driving of slow scalers and slow nuclear modules with fast nuclear pulses of the order of 10 nanoseconds FWHM. The output of the device is a 4.25 volt square pulse when terminated in 50 ohms and is variable in width from 100 to 800 nsec. Since the output is transformer coupled positive or negative pulses may be obtained. The device is constructed of three integrated circuits including (1) a Motorola MC1545L pulse amplifier, (2) a TI SN74121 multivibrator, and (3) a TI SN75450 driver. (W.H.K.)

52299 (COO-3058-10) GATEABLE DELAY-GATE GENERATOR. Tatarczuk, J. R. (Rensselaer Polytechnic Inst., Troy, N. Y. Dept. of Nuclear Science). 1972. Contract AT(11-1)-3058. 4p. Dep. NTIS.

A delay-gate generator for gating of scalers and other instruments and for timing synchronization of slow coincidence pulses is described. The unit consists of five integrated circuits which are diagramed. (W.H.K.)

52300 (EUR-4797) CALIBRATION METHODS OF VACUUM TECHNIQUE. Eschbach, H. L. (European Atomic Energy

Community, Geel (Belgium). Central Nuclear Measurements Bureau). 1972. 34p. (In German). Dep. NTIS (U. S. Sales Only).

The calibration of vacuum gauges and their recalibration have in recent years become more and more important. On one hand, the evaluation of scientific experiments at low pressures very often depends on a precise knowledge of the actual gas density (sorption, diffusion, heterogeneous catalysis). On the other hand, precise pressure measurements are of equal importance for many industrial applications of vacuum technique (determination of pumping speed, conductance, outgassing rates). For some years national and international organizations (PNEUROP, ISO) have been collaborating to establish general rules and regulations to ensure unambiguous and reliable pressure measurements. These difficult investigations have led in some cases to internationally acknowledged norms; in others, only preliminary proposals are available. A short introduction into the problems of precise (absolute) physical measurements is given first; the special difficulties encountered in the absolute measurement of gas densities are then discussed. The efforts to arrive at primary standards for all pressure regions are mentioned. Calibration methods for secondary standards are of special importance for many practical applications. Advantages and disadvantages of methods developed to this end are discussed. (10 figures, 2 tables) (auth)

52301 (EUR-4807) MANUFACTURING SPECIFICATION FOR HIGH TEMPERATURE THERMOCOUPLES FOR USE IN NUCLEAR IRRADIATION EXPERIMENTS. Mason, F. (European Atomic Energy Community, Petten (Netherlands). Joint Nuclear Research Center). 1972. 42p. Dep. NTIS (U. S. Sales Only). EUR B. Fr. 50.-.

This specification details the requirements for materials of construction, methods of manufacture, test procedures, certification, and packing, together with acceptable standards of ancillary processes, which are to be employed in the production of high-temperature mineral-insulated thermocouple units for irradiation experiments. (8 figures, 10 tables) (auth)

52302 (EUR-5100) CAMAC: A MODULAR INSTRUMENTATION SYSTEM FOR DATA HANDLING. SPECIFICATION OF AMPLITUDE ANALOGUE SIGNALS. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). 1972. 10p. Dep. NTIS (U. S. Sales Only). EUR B. Fr. 25.-.

Amplitude analog signals which are recommended for use by CAMAC compatible units are specified. (W.H.K.)

52303 (LA-4999) PROBE VELOCITY TRANSDUCER. Starkovich, V. S.; Todd, B. E.; Stephani, E. L.; Hawkins, E. V. (Los Alamos Scientific Lab., N. Mex.). Sep 1972. Contract W-7405-eng-36. 6p. Dep. NTIS.

A simple velocity transducer for determining x-ray-produced blowoff impulse is described. The device does not require active calibration, and can operate over a wide dynamic range in severe nuclear radiation environments. (6 figures, 3 tables) (auth)

52304 (LIB/Trans-431) EXAMINATION OF BURNOUT DETECTORS BY DIFFERENTIAL CIRCUIT METHODS. Kitayama, Yoshifumi; Namba, Shyunji; Kuniyasu, Yoshihito. Translated for Australian Atomic Energy Commission, Lucas Heights from Nippon Genshiryoku Gakkaishi; 14: No. 4, 9-13(1972). 8p. Dep. NTIS (U. S. Sales Only).

An abstract of this article taken from the original appeared as NSA 26: 33538 (1972). (Australia)

52305 (LMEC-72-4) TRANSIT TIME FLOWMETER: SIX-INCH-DIAMETER WATER AND SODIUM TESTING SUMMARY. De Muri, R. J. (Atomics International, Canoga Park, Calif. Liquid Metal Engineering Center). 15 Aug 1972. Contract AT(04-3)-700. 84p. Dep. NTIS.

An evaluation of the feasibility of using the Transit Time Flowmeter as a precise measurement system for volumetric flow in large circular ducts is presented. The development test program was conducted by Atomics International. The 6-in.-diameter Transit Time Flowmeter was tested in water and liquid sodium systems, following previous work on a smaller 2-in.-diameter device. Operation at elevated temperatures in sodium was satisfactory with the test data indicating an observed bias in measured flow of from 1% low to 5% high and a maximum error of from ±4% to ±9% in water and ±9% to ±15% in sodium. Based on the results of this test program, it is anticipated that a precalibrated device of this size could be built to measure flow velocity to a maximum error of ±3%. (auth)

52306 (RFP-1902) TIME DOMAIN REFLECTOMETRY FOR LIQUID LEVEL MEASUREMENT. Lehmkuhl, George D. (Dow Chemical Co., Denver, Colo. Rocky Flats Div.). 21 Aug 1972. Contract AT(29-1)-1106. 7p. Dep. NTIS.

The time domain reflectometry technique was used to measure liquid levels in a tank. Remote readings of liquid level were easily obtained. The state of the art allows direct readout of volume, level, or pulse travel time through use of proper calibration techniques and a computer–calculator. Calibration and readout using the same fluid allowed level measurement of ±0.3 cm. When solutions of different ionic strengths were used for calibration and readout, the errors in liquid level measurement varied from ±1 cm to ±4 cm. The magnitude of the error depended on the difference in ionic strength and on the trigger voltages used in the electronic instrumentation. (6 figures) (auth)

52307 (SC-DC-721159) RADIATION T[illegible]ANT GATED VIDEO AMPLIFIER. Gray, R. M.; Petty, T. [illegible] (Sandia Labs., Albuquerque, N. Mex.). [nd]. 10p. (CONF-721011-1). Dep. NTIS.

From Government microcircuit applications conference; San Diego, CA. (10 Oct 1972).

The circuit described is a radiation tolerant, gated, differential video amplifier. The amplifier is an all PNP design realized in monolithic integrated circuit form, featuring dielectric isolation, thin film resistors, and gold beam leads. (6 figures) (auth)

52308 (SC-DC-721161) UNIVERSAL DIGITAL INTEGRATED CIRCUIT. Gray, R. M.; Skogmo, D. G. (Sandia Labs., Albuquerque, N. Mex.). [nd]. 13p. (CONF-721011-2). Dep. NTIS.

From Government microcircuit applications conference; San Diego, CA. (10 Oct 1972).

The Universal Digital Integrated Circuit (UDIC) is a radiation-tolerant, beam-leaded design capable of forming with appropriate external pin interconnections any one of four digital circuits. (9 figures, 1 table) (auth)

52309 (SC-DC-721162) DIAMOND: A NEW APPROACH TO MICROELECTRONIC CIRCUIT DESIGN (DIELECTRICALLY ISOLATED ARRAYS OF MONOLITHIC DEVICES). Williams, J. D.; Skogmo, D. G. (Sandia Labs., Albuquerque, N. Mex.). 1970. 11p. (CONF-721011-3). Dep. NTIS.

From Government microcircuit applications conference; San Diego, CA. (10 Oct 1972).

DIAMOND is an approach to microelectronic circuit design which reduces many of the problems associated with the design and procurement of radiation-tolerant integrated circuits. Building block standardization is achieved while allowing special-purpose circuits, when required. (5 figures, 1 table) (auth)

52310 (SC-DC-721302) RETARDING FIELD-CYLINDRICAL MIRROR ANALYZER. Gerlach, Robert L. (Sandia Labs., Albuquerque, N. Mex.). 1971. 15p. (CONF-721003-1). Dep. NTIS.

From nineteenth national vacuum symposium; Chicago, IL. (2 Oct 1972).

An electron energy analyzer system incorporating a two-stage spherical retarding field-cylindrical mirror analyzer as well as high-current, coaxial and glancing incidence electron guns is described. The retarding field and cylindrical mirror analyzers act as high-pass and band-pass energy filters, respectively. The resulting two-stage device has the advantages of both types of analyzers: low shot noise, high transmission, adjustable energy resolution, nearly constant energy resolution and transmission as a function of band-pass energy, and relative insensitivity to sample positioning. The glancing incidence electron gun is mounted directly on the front of the analyzer and is bore sighted onto the sample; the need for deflection electrodes is thereby avoided. Design and performance of this system are examined. (5 figures) (auth)

52311 (UCRL-51130(Vol.8)) FINAL REPORT ON THE DEVELOPMENT OF THE GEOGRAPHICAL POSITION LOCATOR (GPL). VOLUME 8. TECHNICAL SUPPORT. Aley, R. E.; Schiff, A. (California Univ., Livermore. Lawrence Livermore Lab.). 19 Oct 1971. Contract W-7405-eng-48. 56p. Dep. NTIS.

The Geographical Position Locator "A" (GPL-A) system, consisting of a commercial aviation inertial navigation unit and a small external computer, was installed in an instrumented van so that the mathematical error-reduction techniques developed for the GPL system could be tested under realistic conditions. This volume of the GPL final report gives technical descriptions of the equipment assembled for this testing and discusses the various programs that were written for such functions as controlling the inertial platform, calculating position and velocity information, error reduction, motion sensing, and data logging. (38 figures, 9 tables) (auth)

52312 NETWORK FOR ACQUIRING AND REMOTE HANDLING OF DATA USING A SMALL COMPUTER. Le Sourne, M.; Girod, J. J. (CEN, Grenoble, France). Rev. Fr. Automat. Inform. Rech. Oper.; 6: No. B-1, 75-91(Jan 1972). (In French).

A description is given of the transmission network installed at the CEN Grenoble which provides a rapid connection be-

tween experimenters and a data processing computer (IBM 360-50) located a few kilometers away at the computer center. The connection is made using a collecting computer (CII 90–10) and a central make-and-break unit which controls the whole network. The transmission line consists of two coaxial cables distributed in the various buildings. The experimenters connect to these cables by an intermediate terminal. The following devices can be hooked up: multichannel analyzers, block memories, other small computers, and type uniters with paper tape readers and punches. The users have access to processing programs, and catalogs stored on the IBM 360 disks, which can be readily connected to a teletyping machine. The connection is two directional and the results of calculations effected at the center are quickly reviewed by the user. The transmission rate is 750 Kbauds with a useful information transmission rate of 10^5 bits/second. (France)

52313 SAFETY DEVICE FOR REMOVING TRITIUM GAS FROM A GAS STREAM. Benson, Royal H.; Bodre, Robert J. (to Monsanto Co.). U. S. Patent 3,679,366. 25 Jul 1972. Filed 9 Jan 1970.

A safety device for removing tritium gas from flowing fluid streams is described. It is comprised of a means to convert the tritium in the stream to a labile-tritium-containing compound and a trapping means connected to the conversion means such that the fluid stream, upon exiting from the conversion means, flows through the trapping means; the trapping means comprises a means to prevent the escape of the labile-tritium-containing compound to atmosphere. In a specific embodiment, the invention is a safety device for use in combination with gas chromatographic detectors of the electron-capture type, which employ a tritiated material as a source of beta radiation. In these devices the converter means is connected to the outlet of the detector and the trapping means, which in the preferred embodiment takes the form of a tritium-exchange means, is connected to the outlet of the converter means such that the tritium in the labile-tritium-containing compound is exchanged with labile hydrogen in the tritium-exchange means. (2 figures) (auth)

52314 CARRIER TRANSPORT AND STORAGE EFFECTS IN Au ION IMPLANTED SiO_2 STRUCTURES. Chen, L. I.; Pickar, K. A.; Sze, S. M. (Bell Telephone Labs., Murray Hill, N. J.). Solid-State Electron.; 15: No. 9, 979-86(Sep 1972).

To investigate the possibility of fabricating a multilayer gate IGFET using an ion-implanted floating electrode, an MOS structure was made using thermally grown SiO_2 layers into which 100-keV Au^+ ions were implanted. The effects of ion dose (10^{12} to 10^{14} cm^{-2}) oxide thickness (500 to 1000 Å) and postimplantation annealing treatment on the capacitance–voltage and current–voltage characteristics were studied. A significant flatband voltage shift is observed for ion doses larger than 10^{13} cm^{-2}. Most of the interface states created by the implantation damage anneal at 400°C ($N_{ss} \sim 10^{10}$ cm^{-2} for oxide thickness 750 Å). The carrier transport mechanism of the implanted SiO_2 layer is converted from Fowler–Nordheim tunneling conduction to Frenkel–Poole bulk conduction with a trapping energy level 1.2 eV below the oxide conduction band. From these mechanisms the flatband voltage shift due to electrons trapped at assumed localized Au charge storage centers is predicted. This reversible shift is experimentally confirmed by C–V measurements. The time required for a 1-V flatband shift is about 10^{-3} sec when a field of 10^7 V/cm is applied. Thus the resulting MOS structure behaves similarly to a floating gate or multilayer device with obvious simplifications in the processing. It is believed that improvements in reducing the charging time and the writing voltage may be realized by the use of thinner oxides in conjunction with lower implantation energies. (auth)

52315 POTENTIAL MEASUREMENT AND STABILIZATION OF AN ISOLATED TARGET USING ELECTRON BEAMS. Kudirka, P. E.; Crawford, C. K. (Massachusetts Inst. of Tech., Cambridge). Solid-State Electron.; 15: No. 9, 987-92(Sep 1972).

The construction of very large arrays of electronic components on a single semiconductor chip implies a need for new methods of component testing. The presently used contact pads take up too much space. The method proposed uses primary electron beams to excite low-energy secondary electrons which are used to sense surface potentials. The primary electrons are to be allowed to strike only very small diameter metallic contact areas on the interior of a chip, in an environment where surface electric fields are carefully controlled (i.e., no exposed insulator surfaces). Data are presented for a preprototype system using a mockup target and a single large-diameter electron beam. Two operating modes, potential stabilization (corresponding to voltage signal input) and potential measurement (corresponding to voltage signal output), were demonstrated. Accuracies better than 100 mV were observed for both modes using a 5 kV, 10^{-6} A, primary beam. If the method could be extended to multiple small-diameter beams, it could be used to simultaneously inject several voltage signals while measuring output signals from extremely small microcircuits. (auth)

52316 VTAB, PASSIVE IMPULSE GAGE (31 Mar 1972) (Engineering Materials). (California Univ., Livermore. Lawrence Radiation Lab.). (CAPE–2254).

30 drawings.

This passive impulse gage for impulse measurements in a nuclear environment is unaffected by ground motion of 30 to 50 g and using design tradeoffs can be made to extend this level to 1000 g or more, depending on the sample and impulse levels to be measured. A single gage can be designed so that its measuring range is 15 to 20 times its threshold value. The configuration of the gage is a cantilever beam with a sample attached to the free end. The fixed end bends over a curved angle of known radius which serves to define the maximum strain in the beam so that the ultimate strain is not exceeded and plastic bending occurs over some distance rather than at a point. By increasing the width of the beam linearly, starting at the fixed end, the calibration curve of impulse versus angle of bend is nearly linear rather than parabolic as in most passive impulse gages. This gage is relatively inexpensive, for applications in a hostile radiation environment. The gage is relatively insensitive to extraneous shock. An associated computer code, VTAB, calculates design parameters and predicts gage response (30 drawings) (For details see TID-4100 Suppl. 72) (see also 26: 22917) (F.S.)

52317 PASSIVE CRACK-DETECTING SYSTEM (2 Apr 1971) (Engineering Materials). (California Univ., Livermore. Lawrence Radiation Lab.). CAPE–2191).

18 drawings.

This passive-recoverable system determines when a crack occurs in a part which is exposed to neutron radiation. During the first 100 msec after a crack occurs, the part is subject to large thermal stresses and g loading. The assembly can get as warm as 200°F after exposure. This system includes a conductive strip, neutron switch, inertia or g switch, batteries, and tapers. Cracks of ½ mil or larger are detected. Assemblies withstand tests in high g environment as well as at 300°C with no interruption of conductivity (more than 30 kΩ resistance). (18 drawings) (For details see TID-4100 Suppl. 70) (F.S.)

52318 VACUUM LOCK FOR THERMAL-IONIZATION-SOURCE MASS SPECTROMETER (14 Oct 1971) (Engineering Materials). (New Brunswick Lab. (AEC), N. J.). (CAPE–2193).

15 drawings.

A vacuum lock for use on a 12 in. radius multiple-filament-source mass spectrometer reduces sample change time by reducing the volume which must be evacuated to a minimum to allow sample insertion into the vacuum system without disturbing the vacuum significantly. The lock consists of a sample insertion bar, which is supported by "O"-rings fitted into the wall of an evacuation cylinder, and a two inch gate valve located between the source housing and the evacuation cylinder to isolate the source region when a sample is changed. Sample analysis times have been reduced by 50%, from 1 hr to 30 min. Two additional advantages of the lock are: the accelerating voltage (14 kV) no longer has to be turned off during the sample change, and therefore requires no re-stabilization time; the operating pressure of 10^{-6} torr in the source region is lower than that of 2×10^{-6} torr when the vacuum lock is not used. (15 drawings) (For details see TID-4100 Suppl. 70) (see also 25: 39411) (F.S.)

52319 CRYSTAL MOUNT FOR THREE- OR FOUR-CIRCLE X-RAY OR NEUTRON DIFFRACTOMETERS (10 Jul 1972) (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE–2244). 3 drawings.

A crystal mount can be used in place of a goniometer on three- or four-circle x-ray and neutron diffractometers. Such a crystal mount consists of a base and an inexpensive insert for the base. The base provides two of the motions needed to center the specimen and is left on the diffractometer. The crystal is mounted on the insert which also provides the third positioning motion. A key on the insert insures replacement of the insert without change of orientation of the crystal. During the course of crystal structure investigation, it may be necessary to remove the single crystal from the diffractometer several times. The crystal mount prohibits the loss of the knowledge of specimen orientation, saves tieing up the goniometer head, is less expensive, more stable with less bulk, and is less likely to collide with the beam tunnels used on x-ray diffractometers. (3 drawings) (For details see TID-4100 Suppl. 72) (F.S.)

52320 SHAPER WITH UNIVERSAL LOGIC OF OPERATION. Basiladze, S. G. (Joint Inst. for Nuclear Research, Dubna, USSR). Nucl. Instrum. Methods; 103: No. 2, 357-9(1972).

A pulse shaper is described which has a proper dead time of 9 ns and which makes possible pulse counting up to 100 MHz, independent of the nominal duration of the output pulse (smoothly controlled within 5 to 20 ns). The nominal sensitivity of the shaper is 100 mV, and the range of its control is 50 to 350 mV. Electronic control of the duration of the output pulse and the threshold is provided. (4 figures, 1 table) (auth)

52321 DESIGN AND DEVELOPMENT OF A RANDOM PULSE SAMPLER. Khan, M. S.; Vallee, R. L. (Atomic Energy Centre, Dacca, Bangladesh). Nucl. Instrum. Methods; 103: No. 2, 361-4 (1972).

In nuclear experiments it is often required to design an instrument capable of detecting pulses from among a train of random pulses produced by nuclear reactions. An asynchronous random pulse sampler is developed to sample out the first pulse in amplitude and width from among the trains of random pulses. The pulse that arrives immediately after the command "a = 1" is given is considered as the first pulse. Now if, during the transition (0 → 1) of "a" a pulse is already present, then the second pulse must be considered as the first pulse, which must be sampled out. All the first pulses must be sampled entirely in amplitude and width even if the gate "a" closes before the sampling of a first pulse is complete. (7 figures) (auth)

52322 GONIOMETER FOR IMPLANTATION AND CHANNELLING EXPERIMENTS. Pegoraro, A.; Quirci, G. (Joint Nuclear Research Center, Ispra, Italy). Nucl. Instrum. Methods; 103: No. 2, 417-20(1972).

A two-axis goniometer is described, together with facilities for heating or cooling the sample for implantation and channeling experiments. A direct visual control allows an accuracy of 0.05° on both axes, independent of the forward or reverse rotation. (4 figures) (auth)

52323 OPTIMUM CHOPPING. Pearce, J. B. (Univ. of Colorado, Boulder). Nucl. Instrum. Methods; 103: No. 2, 435-6 (1972).

The optimum value of the open aperture fraction for a chopper is derived. The penalty for use of a nonoptimum value is assessed. (2 figures) (auth)

52324 AUTOMATIC DATA ACQUISITION AND REGISTRATION FROM MASS SPECTROMETER. Hoffman, Zbigniew; Kulka, Zbigniew; Sawicki, Aleksander (Inst. of Nuclear Research, Swierk, Poland). Nukleonika; 17: No. 3-4, 217-25(1972).

The instrument serves to digitize voltages representing ion intensity of the mass spectrometer and to print them in digital form together with the time value corresponding to the position of registered peak. The data are printed during the measurement by means of a teleprinter. At the end of the experiment the sum of all registered peak values is printed. A general description of the logic system and electronics used in the instrument is given. (9 figures) (auth)

ISOTOPE AND RADIATION SOURCE TECHNOLOGY

52325 (BNL-50335) BIBLIOGRAPHY OF TECHNICAL PUBLICATIONS AND REPORTS OF THE RADIATION DIVISION, BROOKHAVEN NATIONAL LABORATORY, JULY 1968-JUNE 1971 INCLUSIVE. Kopp, L. E.; Metz, D. J. (Brookhaven National Lab., Upton, N. Y.). Jan 1972. 4p. Dep. NTIS.

A listing of technical publications and reports issued by the BNL Radiation Division from July 1968 through June 1971 is given. References to literature on radiation engineering, process and material development, atmospheric diagnostics, and basic and exploratory research are included. (T.D.)

Isotope Separation (Industrial)

Refer also to abstracts 52975, 52977, 53067, and 53088.

52326 (AREAEE-131) EMPIRICAL EXPRESSIONS FOR THE THERMAL DIFFUSION COLUMN SHAPE FACTORS IN THE EXTREME CYLINDRICAL CASE. Youssef, A.; Saad, S. M.; Hanna, M. M. (Atomic Energy Establishment, Cairo (Egypt). Nuclear Physics Dept.). 1971. 19p. Dep. NTIS (U. S. Sales Only).

Empirical expressions are introduced for the thermal diffusion column shape factors. They were chosen to be simple analytical functions of the ratio of hot-wall to cold-wall temperatures (θ) and the ratio of the cold-wall to hot-wall radii (R) which satisfy certain boundary conditions. These empirical relations are found to reproduce the tabulated values of the shape factors with a sufficient degree of accuracy. They will help to calculate the shape factors for all possible values of θ and R, and for molecules governed by an arbitrary inverse-power potential instead of the interpolation process which has to be applied in conjunction with the tables provided in order to obtain the shape factors corresponding to any particular case. (auth)

52327 (JEN-244) ISOTOPIC SEPARATION BY CENTRIFUGATION. ROTATING PLASMA. Perello, M.; Vigon, M. A. (Junta de Energia Nuclear, Madrid (Spain). Division de Fisica). 1972. 45p. (In Spanish). Dep. NTIS (U. S. Sales Only).

The motion of a gas simultaneously submitted to an electric discharge and a magnetic field was studied in order to analyze the possibility of producing isotope separation by rotation of a plasma. Some experimental results obtained under different discharge conditions are given. Differences of pressure up to 15 mm between both electrodes was attained. No definite conclusion on separation factors could be reached because of the low reproducibility of results, probably due to the short duration of the discharge with a new chamber designed to support stronger thermal shocks more reliable data can be expected. (auth)

52328 URANIUM ENRICHMENT. Benzler, Hartwig. Euro-Spectra; 10: No. 3, 66-72(Sep 1971).

Uranium enrichment by gaseous diffusion, gas centrifugation, and nozzle separation processes are reviewed. Principles of operation, separating capacity, energy consumption, capital expenditures and development potential for each process are discussed. (T.D.)

52329 METHODS OF CALCULATION ON A STEP CASCADE FOR ENRICHING URANIUM. Yamashita, Shizuo (Sumitomo Atomic Energy Industries, Ltd., Tokyo). J. Nucl. Sci. Technol. (Tokyo); 9: No. 8, 480-9(Aug 1972).

A method of calculation is proposed for finding the exact total flow rate of the entering stream fed to the separator in a step cascade in steady state and without losses. The method can be applied without approximation even to step cascades constituted of separators with large values of separation factor. A method of approximation is also presented for application to the case of infinitesimal separator. The reflux in each step can be chosen such that the total flow rate of the entering stream fed to the separator in the step cascade is minimized. The effect on the total flow rate of the entering stream in the step cascade brought by such factors as the mole fraction of production, the number of steps, and the separation factor are revealed from the results of calculation using these methods. The optimization of the stripping section is found to be important for the design of plants producing low-enriched uranium required for nuclear power generation. (auth)

Isotopic Power Sources

Refer also to abstracts 53094, 53551, and 54921.

52330 (BNWL-1308-10) PACIFIC NORTHWEST LABORATORY, ISOTOPE DEVELOPMENT PROGRAMS QUARTERLY REPORT: FEBRUARY-APRIL 1972. Jarrett, J. H. (comp.) (Battelle Pacific Northwest Labs., Richland, Wash.). May 1972. Contract AT(45-1)-1830. 40p. Dep. NTIS.

Research progress is reported on low cost Cs and Sr sources, and development of uses for fission products such as Rh, Pd, Ru, and Tc. Research on neutron radiography using ^{252}Cf is also reported along with results of work on advanced source development, circulatory support systems, and nuclear techniques for seabed mineral exploration. (J.R.D.)

52331 (CEA-CONF-2026) SAFETY ASPECTS OF SEALED ^{238}Pu SOURCES USED IN PACEMAKERS. Boucher, Rene; Barthelemy, Pierre; Milet, Claude (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). 1972. 26p. (In French). (CONF-720519-3). Dep. NTIS (U. S. Sales Only).

From 2nd international symposium on power from radioisotopes; Madrid, Spain (29 May 1972).

A very refined canning was developed, which ensures the complete confinement of the radioisotope. The various safety aspects studied involve: specifications concerning radioactive materials in special form; recommendations formulated by the Study Group on Isotopic Batteries of the ENEA; complementary studies necessary for the manufacture of the sources. The sealed capsules developed are very safe. (France)

52332 (MLM-1150) PREPARATION OF ^{238}Pu METAL. Lonadier, F. D.; Griffo, J. S. (Mound Lab., Miamisburg, Ohio). 12 Oct 1962. Contract AT-33-1-Gen-53. 19p. Dep. NTIS.

The chemical procedures and the processing equipment to prepare plutonium-238 metal for SNAP heat sources are described. Plutonium nitrate is precipitated as the oxalate, the oxalate is converted to the fluoride, and the fluoride is reduced to the metal. Techniques to store and cast the metal are also described. (auth)

52333 (MLM-1213) STUDIES OF ^{238}Pu FUEL FORMS AND THEIR CONTAINMENT. Powers, J. A. (Mound Lab., Miamisburg, Ohio). 8 May 1964. Contract AT-33-1-Gen-53. 10p. Dep. NTIS.

Declassified 2 Nov 1971.

Several forms of the plutonium-238 isotope are being considered for use as radioisotopic heat sources. Compatibility studies of the fuel forms with container materials for various applications are also being carried on. Of the forms studied, plutonium metal is the least desirable for high-temperature applications. The stability, ease of handling, and high melting point of plutonium dioxide make it the first choice among the alternate fuel forms. (auth)

52334 (MLM-1228) ^{210}Po ISOTOPIC FUELS. Kershner, C. J.; Lonadier, F. D. (Mound Lab., Miamisburg, Ohio). 18 May 1964. Contract AT-33-1-Gen-53. 13p. Dep. NTIS.

Declassified 2 Nov 1971.

The physical, chemical, and radiochemical properties of polonium-210 were studied. The properties of polonium-210 are reviewed, and it is shown that the isotope has many properties that make it attractive as an isotopic fuel for SNAP programs. Information concerning various fuel forms and container materials are presented. (auth)

52335 (NASA-TM-X-2440, pp 850-2) DESIGN OF A SOURCE TO SIMULATE THE GAMMA-RAY SPECTRUM EMITTED BY A RADIOISOTOPE THERMOELECTRIC GENERATOR. Reier, Melvin (California Inst. of Tech., Pasadena). Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

A simulated source was designed to duplicate the gamma spectrum of a uniform cylindrical 2200-W PuO_2 radioisotope thermoelectric generator (RTG) containing 81% ^{238}Pu and 1.2 ppM ^{236}Pu. Gamma rays from the decay of ^{238}Pu, ^{241}Am, ^{239}Pu, and the $^{18}O(\alpha,n)^{21}Ne$ reaction were cataloged in broad energy groups. ^{236}Pu, which decays ultimately to ^{228}Th, was treated separately, since an exact duplicate can be made by using ^{228}Th. The selection of sources involves a compromise between half-life, cost, and gamma energy. $^{133}Ba(T_{1/2} = 7.2y)$, $^{137}Cs(T_{1/2} = 30y)$, and $^{60}Co(T_{1/2} = 5.2y)$, which provide gamma rays to cover the spectrum from about 350 keV to 1.3 MeV were chosen. Two 46 and

one 22 mCi ^{228}Th sources provide simulation at various times in the life of the fuel capsule up to 18 years, which covers the time span of an outer planet mission. The emission from the ^{228}Th represents the overwhelming contribution of the gamma spectrum after the first few years. Therefore, the small changes in the intensity of the rest of the spectrum represent a minor perturbation on the entire spectrum. The sources, in the form of 13-inch long rods, are placed in a concentric hole in a cylinder of depleted uranium which provides shielding equivalent to the self shielding of the fuel capsule. The thickness of the ^{238}U cylinder (0.55 cm) was determined by Monte Carlo calculations to insure that the spectrum emerging from the simulated source closely matched that of the fuel capsule. (auth)

53336 (NASA-TM-X-2440, pp 853-8) SOME NEUTRON AND GAMMA RADIATION CHARACTERISTICS OF PLUTONIUM CERMET FUEL FOR ISOTOPIC POWER SOURCES. Neff, R. A.; Anderson, M. E.; Campbell, A. R.; Haas, F. X. (Mound Lab., Miamisburg, Ohio). Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

Gamma and neutron measurements on various types of plutonium sources are presented in order to show the effects of ^{17}O, ^{18}O, ^{19}F, ^{236}Pu, age of the fuel, and size of the source on the gamma and neutron spectra. Analysis of the radiation measurements showed that fluorine is the main contributor to the neutron yields from present plutonium–molybdenum cermet fuel while both fluorine and ^{238}Pu daughters contribute significantly to the gamma intensities. (auth)

53337 (NASA-TM-X-2440, pp 859-61) RADIATION FROM ^{238}Pu USED IN SPACE APPLICATIONS. Keenan, T. K. (Los Alamos Scientific Lab., N. Mex.); Vallee, R. E.; Powers, J. A. Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

Plutonium-238 is an alpha emitter with an 87 year half-life that is produced by neutron irradiation of neptunium-237 in a reactor. Plutonium-238 has been used in all applications of space electric power using isotopes as the energy source. These applications include the SNAP-3, 9, 19, and 27 units. The SNAP-3 and SNAP-9 units were used in Navy TRANSIT satellites while the SNAP-19 was used for auxiliary power aboard a NASA NIMBUS and the SNAP-27 provided all the power for the ALSEP package left on the moon's surface by the Apollo 12 and planned subsequent Apollo landings. The principal mode of the nuclear decay of plutonium-238 is by alpha particle emission at a rate of 17 curies per gram. Gamma radiation also present in the nuclear fuel arises primarily from the nuclear de-excitation of daughter nuclei as a result of the alpha decay of plutonium-238 and reactor produced impurities. The gamma radiation associated with the alpha decay of plutonium-238 ranges in energy from 0.044 to 1.085 MeV. Thallium-208, a subsequent decay product of the reactor produced impurity, plutonium-236, emits 0.583 and 2.6-MeV gamma rays at a significant rate if the initial plutonium-236 content is of the order of one part per million of total plutonium. Plutonium-238 has a spontaneous fission half-life of 4.8×10^{10} years. Neutrons associated with this spontaneous fission are emitted at a rate of 2.8×10^{3} neutrons per second per gram. Since the space fuel form of plutonium-238 is the oxide pressed into a cermet with molybdenum, a contribution to the neutron emission rate arises from (α,n) reactions with ^{17}O and ^{18}O, which occur in natural oxygen and contribute approximately 2×10^{4} neutrons per second per gram of plutonium-238. This contribution can be controlled by ^{16}O enrichment in the fuel. Other (α,n) reactions with low atomic number impurities (principally fluorine) bring the total neutron emission rate from the plutonia molybdenum cermet to near 3×10^{4} neutrons per second per gram of plutonium-238. This contribution can, also, be reduced by proper fuel production techniques. (auth)

53338 (NASA-TM-X-2440, pp 862-5) NUCLEAR RADIATION ENVIRONMENT ANALYSIS FOR THERMOELECTRIC OUTER PLANET SPACECRAFT. Davis, H. S. (California Inst. of Tech., Pasadena); Koprowski, E. F. Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

The radioisotope thermoelectric generator (RTG) nuclear radiation environment analysis of a recent design of the Thermoelectric Outer Planet Spacecraft (TOPS) is presented. The neutron and gamma transport calculations were performed using Monte Carlo methods and a three-dimensional geometric model of the spacecraft. The results were compared with similar calculations performed for an earlier design. (auth)

Radiation Sources

Refer also to abstracts 53109, 53157, 53722, and 54936.

53339 (KFK-1568) INFLUENCE OF DIFFERENT DESIGNS AND MATERIALS ON THE WEAR OF PISTON RING AND PISTON RING GROOVE IN A 6-CYLINDER DIESEL ENGINE. Kaiser, Wilfried (Kernforschungszentrum, Karlsruhe (West Germany). Laboratorium fuer Isotopentechnik). Feb 1972. 104p. (In German). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Karlsruhe Univ. (West Germany).

The wear behavior of different piston ring and piston ring groove designs and of different groove materials in an air-cooled 6-cylinder diesel engine was investigated by means of a radioactive tracer technique. The test parts are activated by neutrons in a thermal reactor and by deuterons and α-particles in a cyclotron. Thus, up to three wear components can be determined simultaneously. Furthermore, the activation by deuterons and α-particles enables the separate measuring of the wear of the upper and lower sides of piston rings and piston grooves. Besides the influence of the lubricant oil temperature the influence of speed and load on the wear was investigated. The results show a very different wear behavior of the plain compression and keystone-rings, of the sides in armored and nonarmored piston grooves, and of the upper and lower sides of piston rings and piston ring grooves. (auth)

53340 PRODUCTION AND TESTING OF HOMOGENEOUS STERILIZATION DOSE DURING RADIOSTERILIZATION. Stenger, V.; Horvath, Zs. (MTA Isotop Intezete, Budapest). Izotoptechnika; 15: No. 3-4, 199-205(1972). (In Hungarian).

The dose distribution in the gamma facility of the Isotopes Institute was determined. A quick and economical dosimetric method for routine dose testing in irradiation boxes is described. (auth)

53341 RADIOTHERAPEUTIC METHOD IN THE TREATMENT OF SKIN CANCER. Scott, R. Kaye (Royal Melbourne Hospital). pp 307-21 of Melanoma and Skin Cancer. /McCarthy, W. H. (ed.). Sydney; Australian Cancer Society (1972). (CONF-720321-2).

From International cancer conference; Sydney, Australia (13 Mar 1972).

Radiotherapeutic equipment is described and the particular advantages of each unit of apparatus for the treatment of skin cancer are discussed. Beta rays are available from radioactive Sr plates of small areas. The effective radiation depth is 2 mm, so lesions of small size (keratoses, dyskeratoses, etc.) are treatable. X-ray therapy machines vary from the Be window unit working at low voltage and short focal skin distance to the superficial and deep x-ray therapy machines to the linear accelerator. Increased applied voltage gives increased beam penetration and increase of focal skin distance increases relative depth dose. The principles governing the prescription of radiation treatment are described and related to depth dose distributions. Uses of radium and radon are briefly described. (Australia)

Industrial Uses

Refer also to abstracts 53346, 53347, 53381, and 53459.

53342 (AED-C-5-11) BIBLIOGRAPHIES IN NUCLEAR SCIENCE AND TECHNOLOGY. SECTION 5. RADIATION EFFECTS ON FOOD. Beising, Kurt (comp.) (Zentralstelle fuer Atomkernenergie-Dokumentation, Leopoldshafen (West Germany)). Jul 1972. 127p. (In English and German). Dep. NTIS (U. S. Sales Only).

References (512) are given to conferences, dissertations, reports, journals, and books published from 1959 through 1969 on the effects of radiation on food, including radiosterilization and radiopreservation. (P.C.H.)

53343 BUILT-IN RADIOTRACER (^{24}Na) FOR MEASURING CATALYST CIRCULATION RATES. Domondon, D. B.; Berbano, M. C. (Philippine Atomic Research Center, Diliman). Philipp. Nucl. J.; 2: No. 2, 231-2(1970).

A radioactive tracer technique using ^{24}Na was adapted for measuring catalyst circulation rates in catalytic cracking units and proved useful in readily providing accurate and reliable data on this critical process variable in petroleum refining. The tracer method and results obtained are described. (L.C.L.)

53344 INFLUENCE OF γ IRRADIATION ON THE CONTENT OF NICOTINIC ACID OF WHEAT, WHEAT-FLOUR, AND WHEAT-BREAD. Washuettl, J. (Technishce Hochschule, Vienna). Ernaehr. Umsch.; 18: No. 3, 95-8(1971). (In German).

Gamma radiation can be applied for pest control purposes in cereals and bakery-goods. Experiments have been made with doses of 50 and 500 Krad on wheat grains, wheat-flour and wheat-bread whose nicotinic-acid-PP-contents have been determined through acid decomposition and, with regard to bread, by means of new methods first published in this paper, i.e., by enzymatic

decomposition, as well as by means of a digestion experiment in vitro. After application of the germination-inhibiting dose of 500 Krad, wheat grains showed an unaltered content of nicotinic acid, whereas wheat-flour showed a decrease, and wheat-bread an increase in vitamin content. In directly irradiated bread the vitamin content was higher than in unirradiated controls, but in bread made from irradiated wheat a loss of vitamins has been found. Considerable differences have been found for the relative values measured for acid decomposition, enzymatic decomposition, and for the digestion experiment. (GF)

LIFE SCIENCES

Radiation Effects on Biochemicals (External Source)

Refer also to abstracts 53021, 53342, and 53381.

53345 (NASA-TM-X-2440, pp 222-8) REVIEW: SOME BIOCHEMICAL EFFECTS OF HIGH LET RADIATIONS. Wiley, Albert L. Jr. (Univ. of Wisconsin, Madison). Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

The natural environment of outer space may theoretically produce a significant exposure of high LET radiation to the space traveler. The use of nuclear reactor power systems may increase this exposure. Since biological endpoints of radiation damage are inevitably due to biochemical changes, it becomes of interest to consider the effect of high LET radiations at the biochemical level. There are qualitative and quantitative differences in the biological damage observed after exposure to high LET radiation (such as heavy ions, protons, neutrons and π^- mesons) as compared to that caused by low LET radiations (such as electrons, x-rays, and gamma rays). This review is concerned with these differences, which are ultimately reflected at the biochemical, cellular, and even whole animal levels. In general, high LET radiations seem to produce biochemical damage that is more severe and possibly less reparable. Experimental data for these effects will be presented in terms of biochemical RBE's with consideration of both early and late manifestations. (auth)

53346 CHARACTERIZATION OF THE RED PIGMENTS PRODUCED FROM FERRIMYOGLOBIN BY IONIZING RADIATION. Giddings, George G.; Markakis, P. (Michigan State Univ., East Lansing). J. Food Sci.; 37: No. 3, 361-4(1972).

It can now be unequivocally stated that there are in fact two red myoglobin derivatives produced by gamma irradiation of ferrimyoglobin solutions under the conditions usually employed in such work. When solutions are anoxic prior to irradiation, a reductive oxygenation to oxymyoglobin takes place (as suggested by earlier work), and in oxygen-containing solutions ferrylmyoglobin is generated. This is consistent with observations that when beefsteaks having an oxidized (brown) surface color are vacuum packaged and irradiated with a pasteurizing dose of ionizing radiation, a purple surface color develops indicative of a reduction of surface ferrimyoglobin. Upon exposure to the atmosphere this radiation-reduced surface pigment oxygenates, becoming bright red, whereas prior to anoxic irradiation the color was brown. Unlike oxygen-containing ferrimyoglobin solutions, however, we have not observed ferrylmyoglobin development of the surface of brown-appearing beefsteaks exposed to irradiation in the presence of oxygen. This may be because catalase activity in the meat tissue removes H_2O_2 as fast as it is produced. The same results were obtained with human hemoglobin as are reported for bovine myoglobin. (auth)

53347 NEWER TRENDS IN PRODUCTION OF CITRUS FRUITS. Penner, H. (Bundesforschungsanstalt fuer Lebensmittelfrischhaltung, Karlsruhe, Ger.). Ind. Obst- Gemueseverwert.; 55: 436-8(1970). (In German).

A report is given on the actual status of citrus production in Israel, on harvesting methods, pest control, packaging, commerce, and transport. Further, the results of experiments on radiation sterilization of food, especially citrus fruits, are discussed. There is no health hazard to be expected due to consumption of irradiated fruits, but certain changes in metabolism of orange skin were observed e.g. increased respiration, activation of enzyme systems, enhanced ethylene formation, and an increase of phenol content. The optical changes of orange skin resulting from this diminish the sales value of fruits. Because of this, the radiation sterilization of oranges seems not to be promising. Nevertheless the scientific investigations on this field are continued. (GF)

53348 MOLECULAR STRUCTURE OF DNA REPLICATION AND RADIATION DAMAGE OF DNA. Okazaki, Reiji (Nagoya Univ., Japan). Igaku No Ayumi; 80: No. 5, 232-43(Jan 1971). (In Japanese).

Studies with intention of clarifying replication, transcription, and their modulation of DNA in bacteria and bacteriophage were carried out from the vie point of molecular biology. Semiconservative replication, model of discontinuous replication, nascent short DNA pieces, DNA chain growth, thymidine and thymidine pulse, discontinuous replication and Kornberg DNA polymerase, discontinuous replication in vitro, and symmetry of discontinuous replication were subsequently discussed laying stress on the experiment of the author. The following statements were made as a result of the study: DNA replication occurred by a discontinuous mechanism (short segment synthesis and "gap filling") followed by "joining"; there seems to exist common causes between replication at replication point and biological repair of radiation disturbance of DNA; and replication areas within DNA molecules were assumed to have higher sensitivity to radiation. (Japan)

53349 DOUBLE-STRAND SCISSIONS IN DNA OF GAMMA-IRRADIATED MICROCOCCUS RADIODURANS AND THEIR REPAIR DURING POSTIRRADIATION INCUBATION. Kitayama, Shigeru; Matsuyama, Akira (Inst. of Physical and Chemical Research, Saitama, Japan). Agr. Biol. Chem. (Tokyo); 35: No. 5, 644-52(May 1971).

Strand scissions in DNA of Micrococcus radiodurans after in vivo irradiation with ^{60}Co gamma rays were investigated by sedimentation analysis using neutral sucrose gradients. Double-strand scission in DNA was estimated to occur at the rate of one double cut per 800 eV. This rate is in good agreement with the value reported for mammalian cells. The rejoining of these double-strand scissions was observed during the repair process of the postirradiation incubation and the mean rejoining time, i.e., the time reducing the remaining fraction of the double-strand scission to 0.37, was found to be 52 min. This rejoining repair was inhibited by adding chloramphenicol, tetracycline, or actinomycin D to the postirradiation incubation medium. It is suggested that the high resistance character of M. radiodurans to gamma rays may be due to the efficient capacity of this rejoining repair. (auth)

53350 MECHANISM OF DNA REPAIR AND RECOMBINATION. Sekiguchi, Mutsuo (Kyushu Univ., Fukuoka). Igaku No Ayumi; 80: No. 5, 244-51(Jan 1972). (In Japanese).

A review of the result of experiments carried out to elucidate the mechanism of DNA repair and recombination, especially the enzymic mechanism of elimination-repair, is presented. Results reported from other laboratories are also reviewed and the present state of research and future problems are described. Mention is made of the enzymes taking part in the repair of DNA, uv-sensitive mutants of T_4 phage, endonuclease specific to DNA irradiated with ultraviolet rays, two steps of incision and excision of nucleotides, including a dimer from uv-irradiated DNA, and the mechanisms of elimination-repair and recombination-repair of DNA from Escherichia coli. (Japan)

53351 ENZYMES FOR REPAIR FOR DNA DAMAGES. Okubo, Shunzo (Osaka Univ.). Taisha; 8: No. 8, 568-75(Aug 1971). (In Japanese).

Repair mechanism for DNA damage is closely related with replication, recombination, and mutation, and the mechanism is explained by enzymes acting on the repair of DNA damages. The role of DNA polymerase in the extract of Escherichia coli in the in vitro repair of DNA is described, centered on the report of Korberg, de Lucia, and Cairns. Reaction mechanism is shown for DNA ligase, which is considered to bind the nicked DNA chain. Some past experiments are given to show that DNA ligase takes part in the replication, recombination, and repair of DNA. (Japan)

53352 X-RAY DAMAGE TO DNA AND LOSS OF BIOLOGICAL FUNCTION: EFFECT OF SENSITIZING AGENTS. Emmerson, Peter T. (Univ. of Newcastle upon Tyne, Eng.). Advan. Radiat. Chem.; 3: 209-70(1972).

A review is presented of the effects of the following sensitizing agents on x-radioinduced damage in DNA: oxygen, N-ethylmaleimide, nitric oxide, and N-oxyl radicals. A discussion is also presented of adduct formation and interference with repair processes as mechanisms of the sensitizing effect. (191 references) (H.L.W.)

Radiation Effects on Cells (External Source)

Refer also to abstracts 53021, 53024, and 53505.

53353 (UR-3490-194) EFFECTS OF ULTRAVIOLET RADIATION ON MAMMALIAN CELLS: JU56 WALLABY CELL LINE. Fu, Ying-Kai (Rochester Univ., N. Y. Dept. of Radiation Biology and Biophysics). 1972. 37p. Dep. NTIS.

Thesis.

An aneuploid marsupial epitheleoid cell line, JU56, derived from the black-tailed wallaby (Protemnodon bicolor), was used for investigating the effects of ultraviolet (uv) light. The cells were grown in monolayer cultures, thereby presenting a more uniform cross section to and permitting the ready penetration of the incident uv light. By means of autoradiography following addition of

^{3}H-thymidine to the media the average generation time was determined to be 17.5 to 18 hrs, which included: 10.5 to 11 hrs for S (DNA synthesis), 2 to 3 hrs for G_2 (post-synthesis interphase), and 4 to 5 hrs for G_1 (pre-synthesis interphase) plus M (mitosis). Severe cellular damage was induced by the uv radiation, resulting in cell death, sterility, delay in DNA synthesis and mitosis, and chromosome aberrations. The various kinds of damage depended upon the intensity of the uv dose. (C.H.)

53354 ESTABLISHMENT OF LINE OF CULTURED OF HEPATOMA CELLS (CULB TC) OF THE RAT AND THE ANALYSIS OF THE EFFECTS OF GAMMA RAYS. Sakka, Masatoshi (Tohoku Univ., Sendai); Katsuta, Hajime; Takaoka, Toshiko. Nippon Igaku Hoshasen Gakkai Zasshi; 31: No. 5, 550-4(Aug 1971). (In Japanese).

Cinemicrograms of four NQO-induced hepatoma cells of the rat, Culb TC, were recorded every 2 min for 130 hr before and after 600 R of a single gamma irradiation. Each cell was followed up and cellular events were indicated in a pedigree. In control pedigrees, mean of the first generation time was 1810 min with a variance of 620^2 min for a sample size of 68. The second and the third generation time were 1992 and 2272 min, respectively, with variance of 588^2 and 964^2. After a single 600 R exposure, about half of the total cell death occurred in the first post-irradiation generation and a quarter in interphase and the residual quarter took place in the second post-irradiation generation. It seems very probable that cell death takes place quite at random in each generation, because mean and variance of cell death was 2700 and 1156^2 min in interphase, 2132 and 1644^2 min in the first post-irradiation generation, and 1730 and 1702^2-min in the second post-irradiation generation. Cellular events were given in tables and their biological characteristics were tested statistically. Differences in the behaviour of the population in usual kinetic analysis and in pedigree studies were discussed. (auth)

53355 BIOLOGICAL DOSIMETERS. I. STUDIES ON THE CHROMOSOMAL ABERRATIONS IN HUMAN LYMPHOCYTES IRRADIATED IN VITRO. Ziemba-Zak, Bogumila; Bocian, Ewa; Kloczewiak, Marek; Kopec, Maria (Instytut Badan Jadrowych, Warsaw). Nukleonika; 16: No. 11-12, 621-31(1971). (In Polish).

The relationship was studied between x-ray dose and yield of chromosomal aberrations (dicentrics, rings, acentric fragments, and minutes) in human lymphocytes in vitro. Frequency of the aberrations was described using two types of regression function: power function $y = ax^b + c$ and second order polynom $y = a_1x + a_2x^2 + c$. The results are better described by the polynom $y = a_1x + a_2x^2 + c$. No statistically significant differences were found between the yield of chromosomal aberrations in cultures of human lymphocytes that were stimulated with phytohaemagglutinin after or before irradiation. (auth)

53356 EFFECTS OF UV-LIGHT AND X-RAYS ON MURINE LYMPHOMA CELLS L5178Y-S IN VITRO. Beer, Janusz Z.; Walicka, Malgorzata (Inst. of Nuclear Research, Warsaw). Nukleonika; 16: No. 11-12, 573-81(1971).

For L5178Y-S cells irradiated with various doses of uv light, survival was determined by growth kinetics observations and by cloning. The dose-survival relationship is exponential and mean lethal dose is about 85 erg mm^{-2}. Observations of the growth of cell cultures irradiated with doses ranging from 16 to 535 erg mm^{-2} were carried for a period of time corresponding to 140 cell generations. The growth was compared of cultures irradiated with 160 and 535 erg mm^{-2} of uv, and with 100 and 300 rads of x rays. In both cases, irradiation caused transitory retardation of the growth of cell populations. It was noticed that the cells lethally damaged by uv disintegrate much more rapidly than those lethally damaged by x rays. All cultures irradiated with uv light after the period of growth retardation grew more rapidly than controls. This phenomenon was not observed after irradiation with x rays. (auth)

53357 RADIATION DAMAGE AND ITS REPAIR. Takebe, Hiraku (Osaka Univ.). Taisha; 8: No. 8, 561-7(Aug 1971). (In Japanese).

A review is made on the repair mechanism of DNA damage, especially by ultraviolet (uv) rays which is known to produce a thymine dimer, a biological effect of uv rays. Past reports on the elucidation of the repair of uv-damaged DNA at the molecular level are reviewed, together with the Elkind–Sutton type recovery of cultured cells damaged by ionizing radiation. The repair mechanism is not limited to radiation damage such as by uv and x rays but is common to damages by various kinds of action source. Effect of radiation is not only lethal but also mutational, and the same repair process works for higher animals and microorganisms alike. (Japan)

53358 THERMALLY ENHANCED RADIOSENSITIVITY OF CULTURED CHINESE HAMSTER CELLS. Ben-Hur, E. (Brookhaven National Lab., Upton, N. Y.); Bronk, B. V.; Elkind, M. M. Nature (London) New Biol.; 238: No. 85, 209-11(16 Aug 1972).

Experiments are described to investigate enhancement of radiation induced lethality of Chinese hamster cells by elevation of temperature at low dose rate. The cells, suspended in DUM 20, were irradiated with 250 kvp x rays, filtered with 0.25 mm Cu and 1.0 mm Al, with a dose rate of 3.3 rad/min, in plastic tubes immersed in water. After irradiation, the cells were diluted and plated for colony formation. Survival curves from cells irradiated at 0, 34, 37, 39, 40, 41, and 42°C are given. It is suggested that the thermally enhanced radiosensitivity that these results indicate is due, at least in part, to inhibition of repair of sublethal damage. (UK)

53359 ANALYSIS OF CHROMOSOMAL SENSITIVITY OF HPK1 CELLS FROM THE MARSUPIAL POTOROUS TRIDACTYLUS TO X RAYS AND TO HELIOTRINE. Bick, Y. A. E. (Univ. of Tasmania, Sandy Bay, Australia); Brown, J. K. Cytobios, 5: No. 19, 189-200(1972).

The relative sensitivity of the individual chromosomes in the diploid cell line HPK1 from the male Potorous tridactylus was analyzed after x irradiation and after heliotrine treatments. In heliotrine experiments, the X chromosome showed a significantly greater sensitivity than the rest of the chromosomes. This was due largely to the sensitivity of the heterochromatic region on the long arm of X. With x rays, up to 8% of the damage occurred in the heterochromatic regions, whereas with heliotrine up to 36% of the total breaks were localized in all heterochromatin. A detailed analysis of chromosomal damage by heliotrine is also given, the results of which suggest that this pyrrolizidine alkaloid inflicts most of its damage during the period of DNA synthesis. For x irradiation, differences in sensitivity were found not only between chromosomes, but the sensitivity of some of the chromosomal elements varied with the stage of the cell cycle during which the x-ray dose was delivered. However, the variation in sensitivity was not simply related to the stage of chromosomal replication. (auth)

53360 METABOLISM OF RICKETTSIA TYPHI AND RICKETTSIA AKARI IN IRRADIATED L CELLS. Weiss, E.; Newman, L. W.; Grays, R.; Green, A. E. (Naval Medical Research Inst., Bethesda, Md.). Infec. Immunity; 6: No. 1, 50-7 (Jul 1972).

L cells that had been exposed to 3,000 R of ^{60}Co γ radiation the previous day were used to study the growth and metabolism of Rickettsia typhi and R. akari. Viable (unirradiated) L cells were used to study the effect of rickettsial infection on host-cell metabolism. Monolayers were infected with a rickettsial multiplicity of 1.2 and given Eagle's minimal essential medium containing 25 mM N-2-hydroxyethylpiperazine-N′-2′-ethanesulfonic acid buffer and 10% calf serum. At various intervals, cycloheximide (2 μg/ml) was added to one set of cultures, to inhibit eukaryotic protein and deoxyribonucleic acid (DNA) metabolism; phosphate-buffered saline (PBS) was added to another set. After 1 hr, the cultures received a mixture of 15 ^{14}C-labeled amino acids or adenine-8-^{14}C. The cultures were harvested 16 hr later and were tested for incorporation of labeled carbon into the fraction precipitated by cold trichloroacetic acid. Viable cells were exposed to thymidine-2-^{14}C for 2-hr periods. Infectivity of R. typhi increased to a peak of 150 to 400 hemolytic units/culture on day 4; the titer remained approximately the same on days 5 and 6, and declined rapidly on day 7. Total amino acid incorporation was about the same in infected and uninfected cultures up to day 6, but metabolic activity was reduced to a negligible level on day 7 in infected cells. Cycloheximide-resistant activity was higher in the infected cultures, with a peak equivalent to one-half the total activity at day 4 to 5. Total as well as cycloheximide-resistant adenine incorporation was higher in the infected cells between days 3 and 5 after infection, with a peak at day 3 to 4. Somewhat similar results were obtained with R. akari, except that the cycle of infection and of cycloheximide-resistant activity proceeded and was completed more rapidly. ^{14}C-DNA of both rickettsiae was isolated from infected cultures that had received labeled adenine. With labeled thymidine, which was not incorporated by the rickettsiae, it was shown that R. typhi and R. akari differ considerably in their effects on the host cell. R. typhi elicited moderate inhibition, whereas R. akari infection led to a complete inhibition of thymidine incorporation by the third day, at the time of highest rickettsial activity. It is concluded that rickettsiae have the necessary enzymes for protein and nucleic acid synthesis, but, thus far, these enzymes have been activated or induced only in an intracellular environment. (auth)

53361 MUTATIONAL ASSAY SYSTEM USING THE THYMIDINE KINASE LOCUS IN MOUSE LYMPHOMA CELLS. Clive, D.; Flamm, W. G.; Machesko, M. R.; Bernheim, N. J. (National Inst.

of Environmental Health Sciences, Research Triangle Park, N. C.). Mutat. Res.; 16: No. 1, 77-87(Sep 1972).

A mutational assay system utilizing the thymidine kinase (TK) locus in L5178 Y mouse lymphoma cells is described. The TK locus is believed to be diploid and the three expected phenotypes — denoted as $TK^{+/+}$, $TK^{+/-}$, and $TK^{-/-}$ — have been isolated and characterized. The $TK^{+/+}$ and $TK^{+/-}$ phenotypes are sensitive to 5-bromodeoxyuridine (BUdR) and resistant to THMG (thymidine + hypoxanthine + methotrexate + glycine) while the $TK^{-/-}$ phenotype is BUdR-resistant and THMG-sensitive. In addition, the thymidine kinase activities of the $TK^{+/+}$, $TK^{+/-}$, and $TK^{-/-}$ clonal lines are, respectively, 61, 27, and 0 μmoles of thymidine phosphorylated per 10^8 cells per min of incubation. And finally, using BUdR or THMG selection medium, the spontaneous $TK^{+/-} \rightarrow TK^{-/-}$ and $TK^{-/-} \rightarrow TK^{+/-}$ mutation rates are $1.2 \cdot 10^{-7}$ and $6.4 \cdot 10^{-9}$ mutations per locus per generation, respectively. In BUdR selection medium concentrations of up to $0.8 \cdot 10^5$ BUdR-sensitive cells per ml can be plated with no effect on the recovery of BUdR-resistant cells; at least $1 \cdot 10^5$ THMG-sensitive cells can be plated in THMG selection medium without affecting the recovery of THMG-resistant cells. Background mutant frequencies can be kept at or below $2 \cdot 10^{-7}$ in $TK^{+/-}$ cultures. Stimulation of the $TK^{+/-} \rightarrow TK^{-/-}$ forward mutation rate was effected with x irradiation, ethyl methanesulfonate (EMS), and hycanthone methanesulfonate. By comparing the observed induced mutation rates with the spontaneous $TK^{+/-} \rightarrow TK^{-/-}$ mutation rate an estimate can be made of the relative mutagenicities of various treatments. Thus, for example, 600 R x irradiation stimulated the mutation rate 2500-fold over the spontaneous rate, while 2-hr exposures to 10^{-2} M EMS or 10^{-4} M hycanthone methanesulfonate gave corresponding stimulations of 17000-fold and 450-fold, respectively. (auth)

53362 MUTAGENESIS IN CULTURED MAMMALIAN CELLS. II. INDUCTION OF GENE MUTATIONS IN CHINESE HAMSTER CELLS. Shapiro, N. I.; Khalizev, A. E.; Luss, E. V.; (and others) (Inst. of Atomic Energy, Moscow). Mutat. Res.; 16: No. 1, 89-101(Sep 1972).

Mutations controlling the resistance to 6-mercaptopurine (6-M) and the ability to multiply in a medium with a low concentration of glucose (glucose-independent mutants) were induced in cultured Chinese hamster cells by N-nitrosomethylurea (NMU), 5-bromodeoxyuridine (BUdR), uv, and x rays. The chemical agents were found to be very active in induction of mutations to 6-M resistance (NMU and BUdR) and mutations of glucose independence (NMU). These agents increase the yield of mutations as compared to the spontaneous mutation rate by about two orders of magnitude. The induced rate of 6-M-resistant mutations by x rays was $2.0 \cdot 10^{-7}$ per viable cell per roentgen. BUdR approximately equally increases the cell's sensitivity to both inactivating and mutagenic action of x rays. The maximum induction of mutations to 6-M resistance by uv was observed at 100 erg/mm^2. This dose leads to a 16-fold increase of the mutation frequency as compared to the spontaneous rate. Further increase of the uv dose up to 200 erg/mm^2 resulted in a lower yield of mutations per dose unit. The highest yield of mutations to 6-M resistance induced by NMU, BUdR, and x rays was observed if cells were plated in selective medium several generations after the mutagenic treatment. The maximum yield of mutations to 6-M resistance induced by uv and of glucose-independence induced by NMU was recorded if cells were transferred to selective media immediately after treatment. The kinetics of expression of mutations and the decline of their number observed after prolonged incubation of treated cells in nonselective conditions are discussed. (auth)

53363 PHENOTYPIC PROPERTIES OF A LARGE-CELL, RADIATION-RESISTANT STRAIN OF ESCHERICHIA COLI. Kvetkas, M. J.; Krisch, R. E.; Zelle, M. R. (Argonne National Lab., Ill.). Can. J. Microbiol.; 18: No. 9, 1417-25(Sep 1972).

Mean cell volumes, total amount of deoxyribonucleic acid (DNA), number of nuclear bodies, and x-ray responses were determined for exponential cultures of Escherichia coli P6, a large-cell radiation-resistant mutant strain, and for E. coli 82/r, the parent strain of P6, growing in three different media at varying growth rates. Combined results comparing cultures in the same growth medium indicated that exponentially growing P6 cells are 2.5 ± 0.2 times larger, contain 3.6 ± 0.3 times more DNA, and 1.8 ± 0.1 times more nuclear bodies than comparable 82/r cells. Individual P6 nuclear bodies contained 2.01 ± 0.13 times as much DNA as 82/r nuclear bodies in comparable cultures, suggesting that each P6 nuclear body may contain two complete 82/r genomes. All P6 cultures gave sigmoidal x-ray survival curves with extrapolation numbers averaging 2.0 and with limiting slopes smaller in absolute value than the slopes of the exponential survival curves obtained for 82/r cultures. P6 cells appeared to be no more efficient than 82/r cells in enzymatic dark repair of x-ray or uv damage, suggesting that the greater x-ray resistance of P6 cells may be associated with the doubled DNA content of each P6 nuclear body. (auth)

Radiation Effects on Microorganisms (External Source)

Refer also to abstracts 53024, 53342, 53347–53351, 53357, and 53505.

53364 (N-72-20063) INDUCTION OF LYSOGENIC BACTERIA IN THE SPACE ENVIRONMENT. Mattoni, R. H. T.; Keller, E. C. Jr.; Ebersold, W. T.; Eiserling, F. A.; Romig, W. R. (California Univ., Berkeley). 1971. 16p. NTIS.

The Biosatellite 2 experiment using the lysogenic bacterium Salmonella typhimurium was designed to test the hypotheses that weightlessness, both with and without gamma irradiation, would affect bacterial cell growth or induction of bacterial prophage. The bacterial data were analyzed by three methods: analysis of variance, t tests between flight and earth control data (where t is the percentage difference between experiment and control sets), and graphic presentation. The data on bacterial growth led to rejection of the hypotheses; space flight produced both increased density of Salmonella typhimurium when grown in liquid medium and interaction to give greater resistance to gamma irradiation at levels between 265 and 1648 R total dose (17 and 103 R per average cell generation). Tests of other variables eliminated all but weightlessness in accounting for the difference. On the basis of the t tests there was no difference in the free phage per bacterium produced under conditions of control and those of flight. The induced bacteriophage per viable bacterium showed significant differences between flight and control at two radiation levels (265 and 645 R). The flight set had consistently lower yields at all levels of radiation. (STAR)

53365 (N-72-20065) RADIATION EXPOSURES DURING THE BIOSATELLITE 2 FLIGHT. Hewitt, John E. (National Aeronautics and Space Administration, Moffett Field, Calif. Ames Research Center). 1971. 14p. NTIS.

Seven of the experiments flown on Biosatellite 2 were designed to determine the combined effects of γ radiation and weightlessness on mortality and mutagenesis in a variety of living systems (insects, microorganisms, and plants) exposed to an onboard source of radiation. Several months after the flight, a series of ground tests was initiated to determine whether the observed effects of interaction were due to vibration and acceleration associated with the flight, rather than to weightlessness. The results of dosimetry measurements indicate that it is unlikely that any difference found to occur between the biologic response of the same experiment in the flight and earth control capsules can be attributed to radiation exposure differences. No unusual results are due to the presence in the capsules of a large component of low energy radiation produced by multiple scattering. (STAR)

53366 (ORO-3347-8) PHYSIOLOGICAL STUDIES ON CLOSTRIDIUM BOTULINUM, TYPE F. Final Report. Walls, Nancy W. (Georgia Inst. of Tech., Atlanta. Engineering Experiment Station). 30 Jun 1971. Contract AT(40-1)-3347. 111p. Dep. NTIS.

A series of experiments was performed to investigate the effects on growth and toxin production, compared to unirradiated controls, of exposure of spores of a proteolytic and a nonproteolytic strain of Clostridium botulinum, type F to sublethal doses (0.1 and 0.2 Mrad) of γ irradiation. This included studies on the ability of these strains of C. botulinum, type F, isolated from natural sources, to grow and produce toxin at a low temperature (10°C). (C.H.)

53367 (SC-RR-720516) FINAL REPORT OF PLANETARY QUARANTINE ACTIVITIES. (Sandia Labs., Albuquerque, N. Mex.). Aug 1972. Contract AT(29-2)-1816. 100p. Dep. NTIS.

This report summarizes the activities of the Planetary Quarantine Department at Sandia Laboratories during the period April 1965 through June 1972. Included are the rationale, the methods and the results of modeling and experimentation used in dry heat, uv radiation, thermoradiation, and chemical sterilization studies and data on the uv sterilization of bacterial spores. A list of publications describing these activities and closely related research is included. (C.H.)

53368 INFLUENCE OF LINEAR ENERGY TRANSFER ON THE RADIORESISTANCE OF BUDDING HAPLOID YEAST CELLS. Raju, M. R.; Gnanapurani, M.; Stackler, B.; (and others) (Univ. of California, Berkeley). Radiat. Res.; 51: No. 2, 310-17(Aug 1972).

The radioresistant component of haploid yeast cells (SC-7) was established by previous investigators to be due to budding cells, and cells with small buds are known to be undergoing DNA synthesis. The response of budding cells of haploid strain SC-7 (Saccharomyces cerevisiae) as a function of LET was studied in this investigation by use of heavy ions (in the LET range 420 to 17,000 MeV g^{-1}cm^2) from the Berkeley heavy-ion linear accelera-

tor. The maximum sensitivity for budding cells occurs at approximately the same LET$_\infty$ (1300 to 1500 MeV $g^{-1}cm^2$) as that for nonbudding cells. The radiosensitivity as a function of LET, of budding haploid yeasts relative to nonbudding cells, is found to be remarkably similar to that of S-phase Chinese hamster cells in culture relative to cells not undergoing DNA synthesis. (auth)

53369 POST-IRRADIATION EVALUATION OF PATHOGENS AND INDICATOR BACTERIA. Tiwari, N. P.; Maxcy, R. B. (Univ. of Nebraska, Lincoln). Contract AT(11-1)-2038. J. Food Sci.; 37: No. 3, 485-7(1972).

The post-irradiation behavior of selected pathogenic and indicator bacteria of public health significance was studied. Stationary cultures of Escherichia coli, Streptococcus faecalis, Staphylococcus aureus, and selected species of Salmonella were exposed to ^{60}Co γ radiation and subsequently handled according to the desired observations. The following conclusions were drawn on the basis of the results obtained: substerilizing doses of radiation kill some bacteria and injure others; survival and recovery are influenced by post-exposure storage time, storage temperature, culture medium, and the radiation dose; irradiation reduced significantly the infectivity of S. typhimurium. (E.R.B.)

53370 PYRIMIDINE DIMERS AS PRE-MUTATIONAL LESIONS IN ESCHERICHIA COLI WP2 Hcr$^-$. Mennigmann, H.-D. (Johann Wolfgang Goethe-Univ., Frankfurt am Main). Mol. Gen. Genet.; 117: No. 2, 167-86(1972).

Mutation to prototrophy in Escherichia coli WP2 Hcr$^-$ induced by far-uv radiation (F-UV) in an intermediate dose range follows dose-squared kinetics. In a comparable dose range with near-uv radiation in the presence of acetophenone (N-UV + Acph), mutation induction follows kinetics that are linearly related to dose. The difference in response to the two types of irradiation is a more general one in that it is the same for true revertants, for suppressor mutants, and for several markers. Double-irradiation experiments together with treatment by photoreactivating light (PR) after the first irradiation (i.e., F-UV → PR → F-UV; N-UV + Acph → PR → N-UV + Acph; N-UV + Acph → F-UV; N-UV + Acph → PR → F-UV) seem to indicate the following: a) the dose-squared kinetics for F-UV are due to the necessary co-operation of at least two types of pre-mutational lesions, only one of which is photoreversible; b) N-UV + Acph also produces these photoreversible lesions in addition to such photoreversible ones that do not require the co-operation of other types; the production of the former is not indicated by the appearance of visible mutants because the non-photoreversible type, whose co-operation is required to give rise to such mutants, is not produced. (auth)

53371 RELATION BETWEEN REPAIR MECHANISMS AND INDUCED MITOTIC RECOMBINATION AFTER UV IRRADIATION, IN THE YEAST SCHIZOSACCHAROMYCES POMBE. EFFECTS OF CAFFEINE. Fabre, F. (Institut du Radium-Biologie, Orsay, France). Mol. Gen. Genet.; 117: No. 2, 153-66(1972).

Two different pathways, A and 1, are known to control the repair of uv lesions in the yeast Schizosaccharomyces pombe. The relation between the uv-induced intergenic mitotic crossing over (MCO) and the repair of prelethal lesions controlled by these pathways was studied in the following strains: UVS1$_{,1}$/UVS1$_{,1}$, where pathway A acts; UVSA/UVSA where pathway 1 acts; UVS$^+$/UVS$^+$ (wild type); and UVS1A/UVS1A (double mutant). The analysis of the survival and MCO induction curves, and the comparison, as a function of the dose and as a function of survival, of the MCO induction curves corresponding to the different strains, show that the repair pathway 1 controls a mechanism involving recombination, and that the repair pathway A controls a mechanism that removes prerecombinational lesions. Studies were done with UVS1$_{,1}$/UVS1$_{,1}$ cells in different physiological conditions affecting the repair efficiency of prelethal lesions (irradiation during the logarithmic growth phase, liquid holding). In all cases, the more efficient the repair of prelethal lesions is, the smaller is the recombination inducibility. This is expected if pathway A controls an excision repair mechanism. The effect of the repair inhibitor, caffeine, was studied. It inhibits only the repair of uv prelethal lesions controlled by pathway 1. The involvement of recombination in the repair of uv lesions in UVS$^+$/UVS$^+$ and UVSA/UVSA cells is also shown by the fact that the sensitization to the lethal effect of uv by caffeine in these strains is correlated with a decrease in uv MCO inducibility. Caffeine has no effect either on the uv survival, or on the MCO inducibility in UVS1$_{,1}$/UVS1$_{,1}$ cells. It is concluded that it inhibits the recombinational repair pathway and not the excision repair pathway. The MCO induction observed in UVS1/UVS1 and UVS1A/UVS1A cells could be due to the presence of a second recombinational pathway, not sensitive to caffeine. At least a fraction of the prerecombinational lesions would not be prelethal, and they are repairable by the excision repair mechanism. (auth)

53372 EFFECTS OF IONIZING RADIATION ON THE CAPACITY OF ESCHERICHIA COLI TO SUPPORT BACTERIOPHAGE T4 GROWTH. Marsden, Howard; Ginoza, William; Pollard, Ernest C. (Pennsylvania State Univ., University Park). J. Virol.; 9: No. 6, 1004-16(Jun 1972).

The loss in capacity of irradiated bacteria to support the growth of T4 phage was studied for two strains, Escherichia coli B and E. coli B$_{s-1}$. Following a dose of 25 krads, the capacity is quite rapidly lost during postirradiation incubation so that after two hr of such incubation at 37 C only 12% remains in strain B and 3% in strain B$_{s-1}$. Evidence that capacity is lost in an all-or-none fashion was provided by two types of experiments: a single-burst analysis of those cells that survived to give a burst; and an analysis of the regulation of an early phage enzyme. Several processes were examined to try to determine the cause of the loss in capacity. These were the ability of the irradiated and postirradiation incubated cells to respire, to allow phage adsorption and injection of phage deoxyribonucleic acid, to support the transcription and translation of an early gene, and to support replication of phage deoxyribonucleic acid. Of these processes, transcription and translation appeared to be the most closely associated with the capacity loss, although respiration was reduced to 50% after 2 hr. (auth)

53373 ULTRAVIOLET-INDUCED CROSSLINKS IN THE DEOXYRIBONUCLEIC ACID OF SINGLE-STRANDED DEOXYRIBONUCLEIC ACID VIRUSES AS A PROBE OF DEOXYRIBONUCLEIC ACID PACKAGING. Francke, Bertold; Ray, Dan. S. (Univ. of California, Los Angeles). J. Virol.; 9: No. 6, 1027-32 (Jun 1972).

Deoxyribonucleic acid (DNA) from ultraviolet (uv)-irradiated ϕX174 sediments in alkali at rates up to 1.7 times that of unirradiated ϕX174 DNA and is observed as a condensed, cross-linked structure when examined in the electron microscope by the formamide spreading technique. This structure appears to result from multipole cross-links induced in the tightly coiled DNA contained within the spherical ϕX174 capsid. In contrast, the DNA extracted after uv irradiation of the filamentous bacteriophage M13 is not strikingly altered in its sedimentation properties and appears by electron microscopy to be rod-shaped as a result of side-to-side association of the circular DNA. The differences in these uv-induced structures reflect the differences in the packaging of the single-stranded DNA in the two virions. (auth)

53374 USE OF MUTAGENIC AGENTS FOR BREEDING OF EREMOTHECIUM ASHBYII, THE PRODUCER OF RIBOFLAVIN. Stepanov, A. I.; Zhdanov, V. G. (Inst. of Genetics of Microorganisms, Moscow). Genetika; 8: No. 6, 86-91(Jun 1972). (In Russian).

A comparative study of the effect of three mutagens (uv-light, diethyl sulphate, and nitrosoguanidine) on the producer of riboflavin in Eremothecium ashbyii revealed no advantage of either of these mutagenic factors over the other two with respect to the induction of plus-variants. At each stage of selection stable mutants exceeding the initial strain in their riboflavin-producing activity were induced by uv-light and nitrosoguanidine. (auth)

53375 INDUCTION AND REPAIR OF GENE CONVERSION IN UV-SENSITIVE MUTANTS OF YEAST. Mori, Shigeyuki; Nakai, Sayaka (National Inst. of Radiological Sciences, Chiba, Japan). Mol. Gen. Genet.; 117: No. 3, 187-96(1972).

Photoreactivation effect on uv-induced allelic recombination was examined using various combinations of leu 1 alleles in uv-sensitive and wild type diploid yeast, Saccharomyces cerevisiae. The frequencies of uv-induced heteroallelic reversion in uv-sensitive strains, presumably lacking dark-repair, are strikingly enhanced compared to those in wild type at the same doses under dark condition. However, these enhanced frequencies of reversion are diminished by photoreactivation almost to the level of those in wild type. The induced frequencies of homoallelic reversion (mutation) of relevant alleles are apparently lower than those of heteroallelic reversion. Phenotypic analysis for linked gene leu 1 on uv-induced heteroallelic revertants has shown that most of the revertants are of the nonreciprocal type recombination (mitotic gene conversion). These results would indicate that most of the dark-repairable damage leading to mitotic gene conversion after uv light is due to pyrimidine dimers. (auth)

53376 INVESTIGATION INTO THE RADIOBIOLOGICAL CONSEQUENCES OF K-SHELL IONIZATIONS OF PHOSPHOROUS ATOMS USING SOFT X RAYS. Clark III, Benton Clyde. New York; Columbia Univ. (1969). 164p. University Microfilms Order No. 72-15,565.

Thesis.

When an x-ray photon ionizes a phosphorus atom in the K-shell, the resulting electron rearrangement ("vacancy cascade") leaves, in general, a residual phosphorus ion of charge +4 due to the emission of three Auger electrons following the ejection of the photoelectron. If such an event occurs to a phosphorus atom located in a biologically important molecule like deoxyribonucleic acid (DNA),

observable consequences may follow since an unusually large amount of ionization and excitation energy is deposited in a very localized region. In the present work, endospores of the bacteria B. subtilis were irradiated with very soft x rays of different energies. The energies used were selected to be above, in some cases, the K edge energy of the phosphorus atom and below, in other cases, this energy. For the latter condition, K-shell ionizations are energetically impossible. An apparatus was developed for investigating this problem by producing high intensity x-ray beams at constant potentials between 1 and 6 kV and currents up to 500 ma. Spores of B. subtilis were produced by growth of vegetative cells on suitable media. The spores were harvested, washed, and stored in cold, distilled water. Aliquots of known concentrations were pipetted onto membrane filters and allowed to dry for at least three days. The filters were irradiated to predetermined exposure levels, both in air and in a high-humidity nitrogen atmosphere. Colony-forming-ability of the irradiated spores was tested by incubating the membrane filters on MR-VP medium. The slopes of the radiation survival curves thus determined were found to be the same, within experimental uncertainty, for x rays of all energies tested provided survival was plotted against the dose delivered to the sporal nuclear body. Although the irradiation apparatus and biological system were carefully selected to detect vacancy cascade damage, no experimental evidence for damage of this type was discerned. The sensitivity of the experiment places a minimum limit of 37 vacancy cascades, on the average, required to inactivate the sporal genome. (Diss. Abstr. Int., B)

53377 LOSS OF PATHOGENICITY BY RADIORESISTANT STAPHYLOCOCCI. Samoilenko, I. I.; Rusakova, E. V.; Pershina, Z. G. (Inst. of Epidemiology and Microbiology, Moscow). Byull. Eksp. Biol. Med.; 73: No. 5, 87-9(May 1972). (In Russian).

Under the effect of repeated irradiation with ^{60}Co gamma-rays, it was possible to obtain radioresistant variants of pathogenic Staphylococci cultures. Radioresistant cultures lost such signs of Staphylococcus pathogenicity as production of plasmocoagulase, DNA-ase, alpha- and delta-hemolysins, dermonecrotic and lethal activity, and capacity to be typed with bacteriophages. There were found no changes in the nucleotide DNA composition of radioresistant variants in comparison with the initial cultures. (auth)

53378 RAPID METHOD FOR COMPLEMENTATION TESTING OF ULTRAVIOLET-SENSITIVE (UVS) MUTANTS OF STREPTOMYCES COELICOLOR. Harold, Richard J.; Hopwood, David A. (John Innes Inst., Norwick, Eng.). Mutat. Res.; 16: No. 1, 27-34(Sep 1972).

Seventy-one uvs mutations were isolated and tested for complementation with mutations representing the known closely linked uvs A, C, and D loci by a rapid replicating technique involving "ultra-fertile" crosses. Most of the mutations were successfully classified by this technique. Of the 71 mutations, 23 were assigned to uvsA, 15 to uvsC, and 28 to uvsD. Four strains may have carried mutations in more than one of the three loci, or conceivably polar mutations. The remaining mutation occurred outside the uvsA, C, D cluster. (auth)

53379 INFLUENCE OF AMINO ACID STARVATION ON THE UV REVERSIBILITY OF THE STRAINS OF ESCHERICHIA COLI B/r THY^- TRP^- HCR^+ AND ESCHERICHIA COLI B/r THY^- TRP^- HCR^-. Slamenova, D. (Inst. of Experimental Oncology, Bratislava). Folia Microbiol. (Prague); 17: No. 4, 274-80 (1972).

The fraction of induced trp^+ reversions in the strains of Escherichia coli B/r thy^- trp^- Hcr^+ and Escherichia coli B/r thy^- trp^- Hcr^- was studied in the course of starvation for an essential amino acid (tryptophan). UV light as a mutagenic factor was used. It was found that there is a decrease in the proportion of induced trp^+ reversions in the strain of Hcr^+ type during starvation. Such a decrease was however observed only with that fraction of trp^+ reversions that is expressed in selective plates where several divisions of irradiated cells are caused. The proportion of trp^+ reversions expressed on minimal plates does not change during starvation. With the strain of Hcr^- type the proportion of induced trp^+ mutations remains unaltered irrespective of the nature of the selective plates. (auth)

53380 SPECIFIC EFFECTS OF MUTAGENS ON ASPERGILLUS NIGER PRODUCING CITRIC ACID. Das, Arati; Nandi, P. (Univ. of Calcutta). Folia Microbiol. (Prague); 17: No. 4, 248-50(1972).

Aspergillus niger C was treated with uv and gamma irradiation (^{60}Co), nitrogen mustard, and colchicine. Mutagenic treatments resulted in substrains with either increased or decreased citric acid production, while some were unchanged in this respect. Low-yielding strains predominated in all experiments. Analysis of the superior substrains showed gamma irradiation to be most effective in producing the greatest number of superior mutants. (auth)

Radiation Effects on Plants (External Source)

Refer also to abstracts 53365 and 53459.

53381 (CNEA-309) EFFECT OF GAMMA RADIATION ON AN ARGENTINE VARIETY OF WHEAT. Pahissa Campa, J.; Herscovich de Pahissa, M. H.; Gabarain, R. V. A.; Tramontini, C. (Comision Nacional de Energia Atomica, Buenos Aires (Argentina)). 1972. 14p. (In Spanish). Dep. NTIS (U. S. Sales Only).

A dose of γ radiation ranging from 15 to 20 krads is normally used for the disinfestation of insect pests in stored grain. Results are reported from a study on the effects of γ radiation on nutritional and organoleptic characteristics of flour produced from irradiated grain. Wheat (an Argentine variety) was exposed to doses ranging from 10 to 2000 krad and data are presented on the effects of the various doses on the weight, moisture content, ash content, and ability to germinate when used as seed. Data are included on the effects of the various doses on the content of moisture, protein, ash, and dry and wet gluten in flour produced from the wheat and on the bread-making characteristics of the flour. The analytical values were found to vary with the radiation dose and marked differences, will respect to the control, were noted in the texture, odor, color, and flavor of bread made with flour from wheat exposed to the higher doses. (C.H.)

53382 (N-72-20054) RADIOBIOLOGIC STUDIES OF TRADESCANTIA PLANTS ORBITED IN BIOSATELLITE 2. Sparrow, Arnold H.; Schairer, Lloyd A.; Marimuthu, Kodumudi M. (Brookhaven National Lab., Upton, N. Y.). 1971. 24p. NTIS.

The Biosatellite 2 Tradescantia experiment was designed to determine the effect of weightlessness and other spacecraft environmental conditions on spontaneous and radiation-induced somatic mutation rates and on selected cytologic changes. Data obtained from γ irradiated and nonirradiated plants flown in Biosatellite 2 were compared with data from nonflight irradiated and nonirradiated plants maintained under conditions similar to those of the flight material. (STAR)

53383 RADIOSENSITIVITY OF SOME CORN VARIETIES. Diaconu, P. An. Inst. Cercet. Pentru Cereale Plante Teh.-Fundulea; Ser. C; 36: 183-91(1968). (In Rumanian).

The radiosensitivity of the ICAR 54, Dobrogean, and Românesc de Studina home varieties, and of the A 19 (home), A 73, and W 32 (U.S.A.) lines was investigated during 1964 to 1967. Radiosensitivity was established by number of emerged plants, by plants having reached maturity, by plants attacked by smut, and by thermal yield. It was found that radiosensitivity differs according to variety and line and according to the investigated character, and this proves that the factors conditioning these characters differ with respect to radiosensitivity. A higher radiosensitivity is found in the Dobrogean variety and in the W 32 line. The A 19 home line is radioresistant. It was found that irradiations favor smut attack and allow thus the discarding of radiosensitive biotypes. (auth)

53384 GENETIC CHANGES INDUCED BY SPACE FLIGHT FACTORS IN THE BARLEY SEEDS TAKEN INTO SPACE ON BOARD THE SPACESHIPS SOYUZ-5 AND SOYUZ-9. Nuzhdin, N. I.; Dozortseva, R. L. (Inst. of Biological Physics, Moscow). Zh. Obshch. Biol.; 33: No. 3, 336-46(1972). (In Russian).

Dry seeds of barley were taken into space on board the spaceships Sojuz-5 and Sojuz-9. On board the ship Sojuz-5 the seeds were in the state of natural rest (the embryonal cells were at G_0 stage). The experiment included two series: untreated seeds were used in Series I; in Series II the seeds were irradiated with ^{137}Cs γ before the flight (15 kR, 620 R/min). Space flight was found to induce chromosomal aberrations. The damage induced by a combined effect of space flight factor (SFF) and γ manifested itself in the two following ways, depending on the physiological state of the cells: The additive effect of the two above factors took place, the seeds having germinated immediately on transition of the embryonal cells from the G_0 stage to the G_1 stage. If the seeds were kept in the open air and subsequently germinated an interaction of the two above effects was observed and the effect of SFF augmented after irradiation. On board the Sojuz-9 the seeds of the above-mentioned species were in a state of induced rest (the embryonal cells were at G_1 stage). One half of non-irradiated seeds taken into space were soaked in the water and the solutions of two radioprotectors. One half of the seeds, both radioprotector-treated and untreated, were irradiated with γ ^{137}Cs (15 kR, 610 R/min). A cytological study of the mitoses in meristemic cells in rootlet terminals revealed that SFF in non-irradiated seeds induced about 3% of aberrant cells. After irradiation the effect of SFF increased over two-fold. Although the radioprotectors ensured the seeds against the γ-induced damage, they failed to protect the seeds from

the SFF-induced damage either in irradiated or non-irradiated seed cells which is inconsistent with the previously obtained data. (auth)

53385 GAMMA STIMULATION OF MAIZE. Caldera, P. G. (Gammatom S.p.a., Gaunzate, Italy). Stimulation Newslett.; No. 2, 5-10(1971).

Maize seeds were irradiated with 100 to 1,200 rads of γ rays before seeding. At the harvest, the number of plants and the weight of maize-cobs and grains were noted and the water content determined. A comparison of grain weight per g of plant revealed an increase as against the control. A statistical evaluation of results is given. (GF)

53386 EFFECT OF γ-IRRADIATION OF SEED ON PROPERTIES OF SUGAR BEET. Mantovani, G.; Fasulo, M. P.; Mancini, F.; (and others). (Univ., Ferrara, Italy). Zucker; 25: No. 4; 113-16(1972). (In German)

Diploid seeds of two different varieties of sugar beet were irradiated with doses of γ-rays from 250 up to 50,000 rads. For two years the effect of different doses of irradiation on the agricultural properties of beets grown from these seed was tested and compared with that of beets grown from seed without preceding irradiation. High doses of irradiation (50,000 rads) caused a marked decrease in the agricultural properties of the beet, while in general no significant differences were obtained after medium and low doses of irradiation. Only in some cases a clear tendency toward improving particular properties of the beet could be found after irradiation with some doses. The results of analogous investigations published in literature are discussed. (GF)

53387 EFFECT OF SEED IRRADIATION WITH ^{60}Co ON SOME PHYSIOLOGICAL PROCESSES AND THE CROP QUALITY IN BEAN PLANTS. Silli, Elena. Lucr. Stiint., Inst. Agron., Bucuresti, Ser. A; 13: 377-83(1970). (In Rumanian).

By irradiating bean seeds with different doses of gamma radiations, physiological modifications occur in plants which are reflected in the crop quality. The small doses of the gamma radiations (500 R and 1000 R) have a stimulative action upon the photosynthesis process and upon the accumulation of dry matter and the higher doses (2,000 R and 6,000 R) have a hindering action. As regards the transpiration intensity, all doses used have determined its decrease. The positive effect of the small doses and the negative one of the high doses is ascertained also as far as the starch and protein contents of the grains is concerned. (auth)

53388 ALTERATIONS OF SUGAR BEETS BY γ-IRRADIATION OF THE SEED. Fasulo, M. P.; Mantovani, G.; Dall'Olio, G.; Berti, M.; Pancaldi, G. (Univ., Ferrara, Italy). Zucker; 25: No. 8, 247-56(1972). (In German).

Experiments were carried out concerning the influence of varying doses of γ irradiation (250 to 50,000 rads) on seed of two diploid sugar beet varieties, one of the high-yielding and the other of the high-quality type. In these investigations the effects on morphology of plants grown in pots as well as in the field, on histological structure of roots in the primary and secondary stage of development, as well as influences on the process of germination were observed. High doses of irradiation (50,000 rads) caused definite damages. Lower doses produced diverse effects difficult to describe. (auth)

53389 STIMULATION OF EMERGENCE BY X-IRRADIATION IN SUGAR BEETS OF DIFFERENT GRADES OF PLOIDY. Pannonhalmi, K. (Noevenynemesitesi es Noevenytermesztesi Kutato Intezet, Sopronhorpacs, Hungary). Stimulation Newslett.; No. 1, 21-2(1970).

Sugar beet seeds of three varieties were irradiated with 5 to 40 kR of x rays at a dose rate of 1,489 R/min. The seeds were stored in desiccators for 100 hrs and subsequently sown. Emergence was noticed daily, with a stimulation being found at different doses. On the 14th day the plants were harvested and the fresh and dry weight determined. A stimulation was recorded which reached a maximum at exactly that dose stimulating emergence for two varieties. (GF)

53390 EFFECT OF IRRADIATION ON VARIABILITY IN OKRA (ABELMOSCHUS ESCULENTUS (L) MOENCH.). Nandpuri, K. S.; Sandhu, K. S.; Randhawa, K. S. (Punjab Agricultural Univ., Ludhiana, India). J. Res. (Ludhiana); 8: No. 2, 183-8 (1971).

Studies on the effect of gamma rays (^{60}Co) on germination, growth, fruit quality, and yield of okra were conducted. Inbred pure seeds of Pusa Sawani var. were irradiated with gamma rays and dosages including the control were 0 Kr, 30 Kr, 40 Kr, 50 Kr, and 60 Kr. The gamma rays retarded the rate of germination and the percentage of germination also tended to decrease with the increase in the dose. Various treatments of gamma rays significantly increased variation for the ht. of plants, either for dwarfness or tallness, for the number of days taken for flowering and for yield in X_1 generation. Plants treated with 30 Kr gamma rays attained significantly more ht. and produced increased yields. One bushy type mutant was observed in the progeny of a plant treated with 60 Kr. Some mutants which were early, late and high-yielders were also spotted out from the progenies of irradiated material in X_2 generation. (Indian Sci. Abstr.)

53391 EFFECT OF LOW DOSES OF X-RAYS ON RADISH AND CARROT. Desai, B. M.; Gaur, B. K. (Bhabha Atomic Research Centre, Bombay). Stimulation Newslett.; No. 2, 27-30(1971).

Seeds of radishes and carrots were irradiated with 100 to 5,000 R of x rays at a dose rate of 100 R/min. The seeds were sown four hrs after irradiation and cultivated in the normal way. After the harvest, the fresh weight of roots and shoots and the length and volume of root were determined. A stimulation of growth was more obvious in roots than in shoots but significant only at 5,000 R. (GF)

53392 WAYS OF FORMATION OF GENETIC HETEROGENEITY AND SOME PROBLEMS OF HETEROSIS SELECTION IN CROSS-POLLINATING AND SELF-POLLINATING PLANTS. I. EFFECT OF BALANCED HETEROZYGOSITY ON THE FREQUENCY OF CHROMOSOME ABERRATIONS IN RYE. Molchan, I. M. (Moscow Agricultural Academy). Genetika; 8: No. 6, 5-12(Jun 1972). (In Russian).

Self-pollination, as compared with free cross-pollination, was shown to increase considerably radiosensitivity and the frequency of chromosome aberrations in rootlets, and to decrease the mitotic activity and germination capacity of self-pollinated rye seeds. (auth)

53393 MUTAGENIC EFFECT OF UV- AND GAMMA-RAYS ON ANTIBIOTIC PRODUCTION OF ASPERGILLUS CHEVALIERI. Nanda, G.; Chandra, A. L.; Nandi, P. (Bose Inst., Calcutta). Curr. Sci. (India); 41: No. 17, 644-5(5 Sep 1972).

Spore suspensions of Aspergillus chevalieri were gamma and uv-irradiated, transferred to agar plates, and biochemical and morphological mutants determined. Increased antibiotic production was observed in several mutants and two were selected for further study. A comparison of the antibiotic activity of the two mutants with that of the parent strain showed that the growth of several species of bacteria was considerably more inhibited by the mutants than by the parent strain. It was also found that the mutants differed in their antibacterial spectra and in the nature of the antibiotics as evidenced by paper chromatography. (H.L.W.)

53394 BIOLOGICAL EFFECTIVENESS OF THE PRIMARY REACTIONS OF THERMAL NEUTRONS. 2. CONTRIBUTION TO THE EFFECTIVENESS OF THE ^{14}N(n,p)^{14}C-CAPTURE REACTION AND ITS COMPONENTS. Knoop, H.-U. (Kernforschungsanlage, Juelich, Ger.). Radiat. Bot.; 12: No. 3, 191-5(Jul 1972). (In German).

Nitrogen-15 fed cells of the unicellular green alga Chlorella pyrenoidosa were suspended in a Polymin-solution of variable concentration and exposed to thermal neutrons. Polymin-SN is a polyelectrolyte, $(CN_2CN_2NH)_n$, of high nitrogen content and low osmotic pressure. From the ^{14}N(n,p)^{14}C-capture reactions of the solution, only the 0.582 MeV-protons are able to pass through the algae, thus giving the possibility to study their biological effectiveness without contribution of the simultaneously produced 0.043 MeV-^{14}C-recoil nuclei. Colony-forming ability of the algae and rate of unusual (mutated) colonies were chosen as criteria for radiation damage. Referred to their dose the external protons proved half as effective as the complete ^{14}N-reaction. The ^{14}C-recoil nuclei with only 7.1% of the dose generated by the ^{14}N-reaction thus showed an extremely high efficiency exceeding that of the protons by a factor of 24.3 ± 14.8 and 16.4 ± 7.2 concerning the reduction of colony-forming ability and the increase of mutation rate respectively. The results supported the hypothesis that both effects were caused by damaged DNA. (auth)

53395 INVESTIGATIONS ON THE CONTENT OF FREE AND BOUND TRYPTOPHAN IN WHEAT AFTER γ IRRADIATION. Washuettl, J. (Technische Hochschule, Vienna). Ernaehr. Umsch.; 18: No. 3, 98-100(1971). (In German).

The effect of gamma radiation, applied for pest control purposes, on the tryptophan content of wheat has been investigated for two different doses. At a dose of 50 Krad, no tryptophan-decreasing effect could be found in wheat and shredded wheat, whereas a dose of 500 Krad resulted in a considerable loss of this amino acid. Furthermore, it has been possible for the first time to reveal the catabolism of the tryptophan bound to a protein. (GF)

Radiation Effects on Animals (External Source)

Refer also to abstracts 53021, 53024, 53505, and 54870.

53396 RADIATION. Harte, John; Socolow, Robert H.; Ginocchio, Joseph N. pp 295-320 of Patient Earth. /Harte, John. New York: Holt, Rinehart, and Winston, Inc. (1971).

Radiation and how it interacts with matter, the biological effects of radiation, and natural and man-made sources of radiation are discussed. Some of the government standards for radiation protection are considered. (M.C.G.)

Man

Refer also to abstracts 53507, 54876, 54877, 54880, 54882, 54883, 54888, 54896, 54897, 54900, 54901, 54906, 54909, 54913, 54914, 54922, 54951, 55454, and 55456.

53397 (FOA-4-4500-A-3) BIOLOGICAL DOSIMETRY FOR APPLICATION ON THE CIVILIAN POPULATION AFTER A NUCLEAR EXPLOSION. Rydberg, Bjoern (Forsvarets Forskningsanstalt, Stockholm (Sweden)). Jun 1972. 22p. (In Swedish). Dep. NTIS (U. S. Sales Only).

Possibilities to use biological dosimetry on the civil population after a nuclear weapon explosion are examined. Biological dosimetry is based on chromosomal aberrations in leukocytes. The cultivation and preparation of blood samples are described. Estimations of the number of cells that have to be examined are done. (KK) (Sweden)

53398 (LA-4874, pp 79-83) BIOMEDICAL PROGRAM. Kligerman, Morton M. (Yale Univ., New Haven, Conn.). Mar 1972.

From fifth LAMPF users meeting; Los Alamos, NM (8 Nov 1971).

Research programs in biomedicine at the Los Alamos Meson Physics Facility are discussed. Consideration is given to the following factors that affect the probability of curing cancer patients: size of tumor; number of cells in the tumor; differential ability of cells to recover from sublethal damage; the oxygen effect; immune responses of the host; and volume of tissue in the tumor. The importance of testing pion beams as a means of cancer treatment is emphasized. (H.L.W.)

53399 (NASA-TM-X-2440, pp 229-32) EFFECTS OF X-RAY IRRADIATION ON HUMAN SPERMATOGENESIS. Thorslund, T. W.; Paulsen, C. A. (Univ. of Washington, Seattle). Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

Direct cell kill and inhibition of mitosis have been suggested as mechanisms to explain the occurrence of absolute sterility following the irradiation of the testes. In order to obtain information on the existence and dose dependency of the mechanisms for man, a controlled study was initiated in 1963. A total of 209 normal adult non-Catholic inmate volunteers at the Washington State Penitentiary in Walla Walla participated in the experiment. Sixty-four of the men received a single midorgan dose to both of their testes ranging from 7.5 to 400 R. The remaining men served as various control groups. Testicular function was evaluated primarily on the basis of weekly seminal fluid examinations where the response or end-point was taken to be azoospermia or complete sterility. In order to obtain direct information on testicular morphological changes, periodic unilateral testicular biopsies were also performed on a number of individuals in both the exposed and non-exposed groups. It was deduced from the resulting length of the pre-sterile period and sterile period data that both cell kill and mitosis halting mechanisms were operating. Estimates of ED_{50} of 75 R and 27 R for cell kill and mitosis halting, respectively, were obtained. The maximum observed sterile period was 501 days with eventual recovery observed in each individual where the follow-up was complete. Thus man appears to be highly radiosensitive in regard to temporary sterility but quite radioresistant in regard to permanent sterility. (auth)

53400 (NASA-TM-X-2440, pp 233-7) MULTIFACTORIAL ANALYSIS OF HUMAN BLOOD CELL RESPONSES TO CLINICAL TOTAL-BODY IRRADIATION. Yuhas, John M.; Stokes, T. R.; Lushbaugh, C. C. (Oak Ridge National Lab., Tenn. Oak Ridge Associated Universities, Tenn.). Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

Multiple regression analysis techniques are used to study the effects of therapeutic radiation exposure, number of fractions, and time on such quantal responses as tumor control and skin injury. The potential of these methods for the analysis of human blood cell responses is demonstrated and estimates are given of the effects of total amount of exposure and time of protraction in determining the minimum white blood cell concentration observed after exposure of patients from four disease groups. (auth)

53401 (NASA-TM-X-2440, pp 238-48) PULMONARY-IMPEDANCE POWER SPECTRAL ANALYSIS: A FACILE MEANS OF DETECTING RADIATION-INDUCED GASTROINTESTINAL DISTRESS AND PERFORMANCE DECREMENT IN MAN. Ricks, Robert C. (Oak Ridge Associated Universities, Tenn.); Lushbaugh, C. C.; McDow, Earl; Frome, Edward. Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

Changes in respiratory variance revealed by power spectral analysis of the pulmonary impedance pneumogram can be used to detect and measure stresses directly or indirectly affecting human respiratory function. When gastrointestinal distress occurred during a series of five whole-body exposures of 30 R at a rate of 1.5 R/min, it was accompanied by typical shifts in pulmonary impedance power spectra. These changes did not occur after protracted exposure of 250 R (30 R daily) at 1.5 R/hr that failed to cause radiation sickness. This system for quantitating respiratory effort can also be used to detect alterations in one's ability to perform under controlled exercise conditions. Performance decrement due to various stresses is difficult to quantitate because of a lack of objectivity in most tests and bias due to different levels of motivation. In our tests, the end point of increased respiratory variance and the method of measuring it is too obtuse for the test subject to recognize and falsify. Increased fatigability has been reported after whole-body irradiation but little is known about doses required and the time for its occurrence. Using pulmonary impedance power spectral analysis we found while observing four irradiated patients that increased fatigability could occur during prolonged fractionated exposures to 10 R daily and after completion of continuous exposures to 30 R/day for 5 days. The performance decrement detected by this means occurred at lower total doses than previously reported for radiation-induced fatigue and at lower exposure rates than those that cause gastrointestinal distress. (auth)

53402 (NASA-TM-X-2440, pp 398-415) PREDICTED LEVELS OF HUMAN RADIATION TOLERANCE EXTRAPOLATED FROM CLINICAL STUDIES OF RADIATION EFFECTS. Lushbaugh, C. C. (Oak Ridge Associated Univ., Tenn.). Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

Results of clinical studies of radiation effects on man are used to evaluate space radiation hazards encountered during manned space travel. Considered are effects of photons as well as of mixed fission neutrons and gamma irradiations in establishing body radiosensitivity and tolerance levels. Upper and lower dose-response-time relations for acute radiation syndromes in patients indicate that man is more than sufficiently radioresistant to make the risks of an early radiation effect during one short space mission intangibly small in relation to the other nonradiation risks involved. (auth)

53403 (NASA-TM-X-2440, pp 416-22) HUMAN VISUAL RESPONSE TO NUCLEAR-PARTICLE EXPOSURES. Tobias, C. A.; Budinger, T. F.; Lyman, J. T. (Univ. of California, Berkeley). Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

Experiments with accelerated helium ions were performed in an effort to localize the site of initial radiation interactions in the eye that lead to light flash observations by astronauts during spaceflight. The character and efficiency of helium ion induction of visual sensations depended on the state of dark adaptation of the retina; also, the same events were seen with different efficiencies and details when particle flux density changed. It was concluded that fast particles cause interactions in the retina, particularly in the receptor layer, and thus give rise to the sensations of light flashes, streaks, and supernovae. (auth)

53404 (NASA-TM-X-2440, pp 424-34) USE OF QUALITY FACTORS AND FLUENCE TO DOSE-RATE CONVERSION IN HUMAN RADIATION EXPOSURES. Sondhaus, C. A. (Univ. of California, Irvine). Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

It has not yet been possible to use biological data with the same degree of precision with which one can obtain or estimate physical radiation data. Certainly, a QF, even properly used, is by no means the only modifying factor that one must apply to a flux-to-dose conversion; the distribution factor and the time factor are there to contend with, and the area factor as well. But above all, one must at least consider the possibility of treating a total exposure not simply on the basis of a collection of separate organs wired together, each with its own sensitivity, but by applying a separate organ approach only very judiciously as a part of the characterization of a total body exposure. It would seem that the most reasonable way one can use the human data that exists is to apply it as far as possible to the human animal as a whole. The

particular dosimetric problems of the space environment have been a stimulus to such efforts, but the results can clearly be useful in terrestrial human affairs. (auth)

53405 (NASA-TM-X-2440, pp 767-72) DIRECT STIMULATION OF THE RETINA BY THE METHOD OF VIRTUAL QUANTA FOR HEAVY COSMIC-RAY NUCLEI. McNulty, P. J. (Clarkson Coll. of Tech., Potsdam, N. Y. Air Force Cambridge Research Labs., Bedford, Mass.); Madey, Richard. Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

The method of virtual-quanta is based on the fact that the electromagnetic field of a fast charged particle approaches the field of a plane wave as the particle speed approaches the speed of light. The electromagnetic field of a particle that passes through the retina appears to a rod in the retina as an electromagnetic pulse in time. The quantization of the components of the Fourier frequency spectrum of this pulse of electromagnetic radiation yields the virtual quanta. This method assumes that the virtual-quanta interact with the retina in the same way as ordinary photons. We have calculated the contribution to the frequency of visual sensations induced in the dark-adapted eye by the virtual-photon field associated with the heavy-nuclei that exist in the region of space beyond the geomagnetic field. In order to determine the probability that the virtual-photon field induces a light-flash, we utilize only the portion of the virtual-photon spectrum that corresponds to the known frequency dependence of the sensitivity of human rods to visible light. The results of our calculation can be expressed as a curve of the mean frequency of light-flashes induced by the absorption of at least R virtual-photons versus the threshold number R. The contribution to the light-flash frequency from the virtual-photon field of heavy cosmic-ray nuclei is smaller than that from Cherenkov photons. We have used the flux and energy spectra of galactic cosmic-ray nuclei helium to iron measured by Comstock, Fan, and Simpson. (auth)

53406 (NASA-TM-X-2440, pp 974-80) DOSIMETRY FOR RADIOBIOLOGICAL STUDIES OF THE HUMAN HEMATOPOIETIC SYSTEM. Beck, W. L.; Stokes, T. R.; Lushbaugh, C. C. (Oak Ridge Associated Universities, Tenn.). Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

The three total-body irradiation facilities at Oak Ridge Associated Universities are described. The methods used to determine the γ dose to human bone marrow in these facilities are described including the use of an Alderson Rando phantom and the use of extruded lithium fluoride dosimeters in the phantom. The method used for calculating the bone marrow dose is discussed. The average dose in rads/100 R in the various marrow compartments is given for each of the irradiation facilities. (E.R.B.)

53407 (NASA-TM-X-2440, pp 1002-6) OBSERVATIONS OF COSMIC-RAY-INDUCED PHOSPHENES ON APOLLO 14. Chapman, P. K. (Manned Spacecraft Center, Houston, Tex.); Pinsky, L. S.; Benson, R. E.; Budinger, T. F. Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

The observations of cosmic-ray phosphenes on Apollo 14 were very simple, required no equipment, and were carried out on a time-available basis. They provided the first quantitative data on the statistics of this phenomenon, but by far the most significant result was the discovery that it is not necessary to be dark-adapted to see flashes. This is strong evidence that some, and probably most, of the flashes are produced by mechanisms other than Cherenkov radiation. It is probable that many of the flashes are due to direct ionizing interactions in the retina. This conclusion is supported by experiments of Tobias and his associates, in which flashes were observed by subjects exposed to low-energy neutron beams. Neutrons, being uncharged, of course cannot produce Cherenkov radiation directly, and the beams employed were energetically incapable of producing charged spallation products of sufficient velocity. (auth)

53408 (NASA-TM-X-2440, pp 1007-15) HEAVY-PARTICLE HAZARD: WHAT PHYSICAL DATA ARE NEEDED? Curtis, S. B. (Univ. of California, Berkeley); Wilkinson, M. C. Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

Several areas are mentioned where physical data are needed in order to evaluate adequately the potential hazard of high-energy heavy ions in the galactic cosmic radiation to long manned missions outside our magnetosphere. The first, more data on the lower energy portion of the differential energy spectrum of the iron group, can be obtained in appropriately instrumented satellites during the next period of solar inactivity 1975 to 1977. The other two areas, nuclear interaction parameters in tissue and aluminum and the structure of the energy deposition along the trajectory of the tracks, appear to require an accelerator that accelerates ions of the iron group up to at least 300 to 500 MeV/nucleon. This information, along with the necessary biological information concerning the extent of damage and functional impairment to various critical organs, is necessary before we can confidently send manned expeditions to explore the near planets or establish bases for extended exploration of the moon. (auth)

53409 (STI/PUB-295(Vol.4)) ATLAS OF RADIATION DOSE DISTRIBUTIONS. VOLUME IV. BRACHYTHERAPY ISODOSE CHARTS SEALED RADIUM SOURCES. Stovall, Marilyn; Lanzl, L. H.; Moos, W. S. (International Atomic Energy Agency, Vienna (Austria)). 1972. 142p. IAEA $20.00.

This volume of the Atlas of Radiation Dose Distributions is devoted to brachytherapy isodose charts for sealed ^{226}Ra sources used for therapy. Part I comprises the main text, bibliography, a list of suppliers of sources and accessory equipment. Part II includes 192 isodose charts of the γ dose distribution. (C.H.)

53410 RADIATION PROTECTION PROSTHESES FOR EDENTULOUS PATIENTS. Aramany, Mohamed A.; Drane, Joe B. (Univ. of Pittsburgh. M. D. Anderson Hospital and Tumor Inst., Houston, Tex.). J. Prosth. Dent.; 27: No. 3, 292-6(Mar 1972).

A simplified technique for the construction of radiation protection prostheses for edentulous patients is described. A direct wax pattern is formed on a cold-curing acrylic resin base. A direct method for applying radiation shield material in the stent is incorporated in the procedure. (auth)

53411 CLINICAL ASPECTS OF RADIATION INJURY SIMULATION AND RECUPERATION. Gus'kova, A. K. (Inst. of Industrial Hygiene and Occupational Diseases, Moscow). Med. Radiol.; 17: No. 8, 7-15(Aug 1972). (In Russian).

Difficulties arising in simulating radiation injuries and recovery in man are analyzed. The author's personal clinical experience and literature sources served as a background for recommendations as to the choice of the most suitable classification of clinical forms, significant dosimetric parameters, and a rational simplification of the intricate pathological process, bringing it to the level of a critical structure or function allowing one to quantificate the lesion and post-radiation recovery. Mention is made of peculiarities particular to the solution of these problems with special reference to systems and organs presenting different anatomo-functional organization. (auth)

53412 MORTALITY EXPERIENCE OF THE COMMUNITY AND OF THE FLUORSPAR MINING EMPLOYEES AT ST. LAWRENCE, NEWFOUNDLAND. de Villiers, A. J.; Windish, J. P.; Brent, F. de N.; (and others). Occup. Health Rev.; 22: 1-15(1971).

Data are summarized from an epidemiological survey of mortality at St. Lawrence, Newfoundland, a community where approximately 2,000 men had been employed in fluorspar mining for various periods of time. Surveys conducted during 1959 showed high concentrations of radon and radon daughter products in the mine air, although there was no known source of any uranium ore. The installation of additional mechanical ventilation in 1962 resulted in concentrations of airborne radioactivity below the safety level. The relationship between occupational factors and causes of death was studied using mortality data for the years 1933 to 1968, during which 250 deaths occurred for miners. Data are tabulated on the number of malignant neoplasms of all sites, and those involving the trachea, bronchus, and lungs; tuberculosis of the respiratory system; other respiratory system diseases; and accidents. One-hundred and fifty-five deaths occurred among individuals who had accumulated more than 1,000 underground working hours, of which 78 (50.3%) were due to lung conditions, including 52 cases (33.5%) of lung cancer, 11 cases (7.1%) of malignant diseases of the buccal cavity and gastrointestinal tract, and 20 cases (12.9%) of tuberculosis death. A review of the lung cancer deaths showed the average age at death to be 48.9 years, with the average age at first exposure being 21 years, or a latent period between first exposure to radon and death of 21.7 years. (C.H.)

53413 MEDICAL USES OF IONIZING RADIATION AND RADIOISOTOPES. REPORT OF A JOINT IAEA/WHO EXPERT COMMITTEE. World Health Organ., Tech. Rep. Ser.; No. 492, 1-56 (1972).

The medical uses of radiation have gradually expanded and three separate disciplines have emerged: radiodiagnosis, radiotherapy and nuclear medicine. A Joint IAEA/WHO Expert Committee examined the benefits that can be derived from the medical uses of radiation and radioisotopes, and the means of obtaining the best results. The use of diagnostic radiology has increased dramatically in the highly developed countries, where over half the population is likely to receive an x ray diagnostic examination each year. The Committee considered the possibilities of

improving existing services and the number and type of examinations for which facilities should be made available. The equipment and supplies needed by departments of diagnostic radiology and the training of personnel are also discussed. Radiotherapy has now become one of the most important methods of treating cancer, taking its place alongside surgery as a method for both curative and palliative treatment. The Committee considered the organization of radiotherapy departments, with particular reference to the accommodation, equipment, and staff required. During the last 10 years there has been a rapid increase in the applications of unsealed radioactive materials for diagnostic and therapeutic purposes, and nuclear medicine has now become an established branch of radiation medicine. A brief account is given of the types of procedure now available, the types of establishment in which these procedures can appropriately be carried out, and the facilities required. Attention is paid to objectives and priorities in the development of nuclear medicine services. A number of conclusions are presented and recommendations for improvements are included. (C.H.)

53414 LATE EFFECTS OF ATOMIC RADIATION. Shiomi, T. Bild Wiss.; 9: No. 5, 466-75(1972). (In German).

For many years, experts have held the view that the fission products of the fallout and the residual radiation resulting from the explosion of the atomic bombs over Japan have not produced any biological effect. This view has now been overthrown by an investigation on inhabitants of Nagasaki. Three test groups were examined for chromosomal aberrations, and it was found that persons subjected to residual radiation showed a significantly higher percentage of chromosomal aberrations than a control group that had not been exposed to radiation. According to the author, the radiation exposure caused by the explosion of the atomic bomb over Nagasaki is to be regarded as a special case within the framework of a generally increasing contamination of the environment by artificially induced radiation. (GF)

53415 THERMOLUMINESCENT DOSIMETRY IN PATIENTS TREATED WITH HIGH-ENERGY ELECTRONS. Van Dam, J. (Academisch Ziekenhuis St. Rafaeel, Louvain, Belgium). J. Belge Radiol.; 55: No. 2, 293-6(1972). (In Dutch).

Thermoluminescent dosimetry was used as a daily check of the reproducibility of the ratio of the dose delivered to the dose asked by the doctor for patients irradiated with electrons of high energy. A special study was devoted to cases where the curvature of the skin surface rendered difficult correct and reproducible positioning of the patient. From one therapeutic session to another the differences between the ratios of the dose delivered to the dose asked can be of the order of 10%. (auth)

53416 DOSIMETRY IN RADIODIAGNOSIS. Van Elegem, P. (Univ. Libre, Brussels); Brunfaut, C.; Lejeune, S. J. Belge Radiol.; 55: No. 2, 271-83(1972). (In French).

The doses absorbed by the patient for various classical tests in diagnostic radiography were measured in a tissue equivalent phantom. These measurements were compared with those given in the literature and a method for predetermination of absorbed doses is suggested. The paper ends with a recall of means to be used to reduce the dose at the patient level, all necessary information for the diagnosis being kept. (auth)

53417 PEDIATRIC RADIOLOGY AND IRRADIATION. Claus, D.; Gillet, R.; Wambersie, A. (Univ., Louvain, Belgium). J. Belge Radiol.; 55: No. 2, 163-9(1972). (In French).

Protection in pediatric radiology presents a particular problem as the child is especially sensitive to x rays and is in fact very often unnecessarily overexposed. A correct adjustment of the apparatus and of the test techniques is indispensable. On the basis of a few measurements, a tentative estimate of the doses received by the child during radiological tests was made, as well as of the way the irradiation varies according to the utilized technique. (auth)

53418 OSTEORADIONECROSIS OF THE MANDIBLE. Rankow, Robin M.; Weissman, Bruce (Columbia Presbyterian Medical Center, New York). Ann. Otol., Rhinol., Laryngol.; 80: No. 4, 603-11(Aug 1971).

The usual accepted incidence of osteoradionecrosis of the mandible after radiotherapy for a head and neck cancer is 5 to 10%. The trend to higher doses of irradiation with megavoltage and hyperbaric oxygenation techniques is providing a greater cure rate, but increases severe complications such as osteoradionecrosis. Surgical treatment is indicated after one year of intractable pain or bone exposure unresponsive to vigorous medical therapy. Orocutaneous fistulization is a more immediate cause for surgery. The technical advantages of intraoral hemimandibulectomy are emphasized. (auth)

53419 COMBINED RADIATION INJURIES. Messerschmidt, O. Strahlenschutz Forsch. Prax.; 11: 78-90(1971). (In German).

Combined radiation injuries and traumatic injuries are discussed, especially with respect to the Russian literature. The healing of traumatic skin injuries following whole-body irradiation is considered and early and complete closure of the wounds is recommended. Also the combination of irradiation and gunshot wounds is considered. Prognosis and type of treatment depend on the time interval between irradiation and infliction of the wound; surgical treatment of abdominal injuries yields much poorer results in irradiated animals. Best results are obtained when surgery is performed during the latent period, after subsiding of the initial reaction. The combination of radiation with thermal burns is considered, and the effects of irradiation on the results of skin transplantation and on the healing of bone fractures are reviewed. (H.B.G.)

53420 CHROMOSOME ANOMALIES FOR BIOLOGICAL DOSIMETRY. Fritz-Niggli, H. Strahlenschutz Forsch. Prax.; 11: 36-47(1971). (In German).

The feasibility of using chromosome aberrations in human lymphocytes as a biological dosimeter is reviewed. It is concluded that doses of about 10 rem can be detected. Only for high doses delivered in a short time, a clear dose-effect relationship can be established. Chromosome analysis may be of value in installations with high accident risks. In any case, chromosome analysis should be performed on every person before employment in such installations. Disadvantages of chromosome analysis are the facts that the method is time-consuming and that aberrations can also be produced by chemicals and viruses. (H.B.G.)

53421 IMAGE INTENSIFIERS AND FLUOROSCOPY STABILIZERS. Airth, G. R. (Southmead Hospital, Bristol, Eng.). Brit. J. Radiol.; 45: No. 536, 627(Aug 1972).

The problems of achieving a constant and adequate input x ray dose rate to an image intensifier when fluoroscopy stabilization is in use during diagnostic radiography are briefly considered. Patient hazards are considered as the intensifier ages and the stabilizer needs more current. It is pointed out that a maximum number of patients should be examined using one image intensifier, because of its relatively short working life. The need for frequent checks on currents and dose rates is also emphasized. (UK)

53422 DOSIMETRY IN INTERSTITIAL THERAPY ^{192}Ir WIRES (PARIS TECHNIQUE): APPLICATIONS IN ONE PLANE. Wambersie, A. (Institut du Cancer, Louvain, Belgium); Dutreix, A.; Pierquin, B.; Dardenne, J. C. J. Belge Radiol.; 55: No. 2, 197-206(1972). (In French).

The results of a previsional dosimetric study in interstitial therapy are presented. They concern applications in one plane of rectilinear, parallel, equidistant ^{192}Ir wires ("Paris technique"). Dose distribution in orthogonal planes was computed systematically for different arrangements of the wires (number, length, separation). From these results, the dimensions of the target volumes that can be treated by an application of 1, 2, ... 5 coplanar wires are determined. For this aim, four rules for the applications are defined and discussed. Diagrams are proposed for the evaluation of the numbers of wires to be used as a function of the dimensions of the volume to be treated. Then, other diagrams allow to evaluate the separation between the wires and the reference dose to be chosen. Two examples are discussed. (auth)

53423 CLINICAL CONTRIBUTION TO THE UNDERSTANDING OF RADIATION-INDUCED SIALOADENITIS. Jucker, C. (Univ., Pavia, Italy). Radiaz. Alta Energ.; 11: No. 1, 21-38(Jan 1972). (In Italian).

A description of two cases of inflammation of the salivary glands caused by therapeutic irradiation is presented. The following aspects of this quite infrequent complication are described: chemical aspects; sialographic reports; the element which, in laboratory analyses, provide evidence of sialoadenitis due to massive irradiation, namely hyperamylasaemia; and the anatomic-histological substratum. (auth)

53424 RADIATED DOSE TO SKIN OF FINGERS DURING INJECTION OF RADIOACTIVE SUBSTANCES. Takaku, Yuji (Fukushima Medical Coll., Japan); Kida, Toshiyuki. Rinsho Hoshasen; 16: No. 10, 814-16(Oct 1971). (In Japanese).

With the development of nuclear medicine, the frequency of radioisotope application has greatly increased, and exposure of the operators' fingers at injection has become a problem. The exposure of the operator due to routine operations was determined. Gold-198, ^{131}I, ^{203}Hg, and ^{59}Fe, which are often used for clinical examination, were applied as radioactive substances. Doses of 10 μCi of ^{59}Fe and 100 μCi of the other substances were placed into either 1 ml or 2.5 ml plastic syringes. Oil clay models of the fingers were made, and the conditions of the exposure were determined with a thermoluminescent dosemeter for counts on skin, and Toshiba fluorescence glass dosemeter for counts on bone. As the result, the exposure decreased conspicuously with increasing distance from the radioisotope filled part of

the syringes. The maximum dose limit permitted by law is 20 rem for 3 months. Frequencies corresponding to the limit for each isotope are shown. The larger syringe showed less exposure. The exposure depended on γ-ray energy rather than β-ray energy, and higher exposures were obtained by higher energies. (Japan)

53425 TWO AUTOPSY CASES OF RADIATION MYELOPATHY. CONSIDERATION ABOUT THE PATHOGENESIS. Okeda, Riki (Tokyo Medical and Dental Univ.). Shinkei Kenkyu No Shinpo; 15: No. 3, 619-39(Aug 1971). (In Japanese).

Two autopsy cases of radiation myelopathy are reported. Case 1 was a 51 year old man with carcinoma of the larynx, to which a tumor dose of 7100 R/65 days by Tele-therapy (^{60}Co) was administered from the bilateral sides of the neck. Each field size was 8 × 10 cm. Thus, from the 2nd to 7th cervical vertebrae were involved in the direct beam. Case 2 was a 38 year old man with carcinoma of the epipharynx with metastasis to the bilateral submaxillary lymph nodes. To these lymph nodes, a tumor dose of 5986 R/48 days by Tele-therapy (^{60}Co) was administered in the same way as in case 1. In the direct beam, this time, from the 2nd to 5th cervical vertebrae were involved. Localization of lesions in the spinal cord of these two cases corresponded to the area exposed to the direct beam of ^{60}Cc, namely, in case 1 from the 5th to 7th cervical segments and in case 2 from the 3rd to 4th cervical segments. In neither case was tumor invasion in and around the spinal cord, deformation of vertebrae, or vascular anomaly in the arachnoidea found. The spacial dispositions of the parenchymal lesions were closely related with the pathological changes of vessels, from capillaries to veins. It was not possible to determine if these vascular changes were secondary to the parenchymal alterations. Similarity of these parenchymal and vascular changes with Foix-Alajouanine's disease is discussed in the paper. As for the cause of these changes, increase of intramedullary venous pressure, which is mainly due to disturbance of venous return by venous lesions in the arachnoida and arterio-venous shunt developed or newly formed secondary to decrease of capillary beds, is considered. (Japan)

53426 EVALUATION OF EXPOSURE DOSES TO PERSONNEL AT HIGH-POWER BETA RADIATION INSTALLATIONS. Korenkov, I. P.; Mamin, E. B.; Chistov, E. D. At. Energ. (USSR); 32: No. 5, 434-5(May 1972). (In Russian).

Personnel at high-level beta installations are subjected to mixed β-γ radiations, the γ component being comprised of bremsstrahlung and accompanying radiations. An analysis of the B, γ, and $\beta + \gamma$ doses received by five different parts of the body was tabulated for assembly–disassembly workers and for operating personnel. A comparison of these data with corresponding phantom measurements showed that the worker constantly changes his orientation relative to the radiation sources, with the hands and pelvis, in particular, receiving smaller doses than those of the phantom. (K.S.W.)

53427 CHROMOSOME ABERRATIONS FOLLOWING REPEATED GASTRIC ROENTGEN EXAMINATIONS. Hajdu, Imre. Orv. Hetil.; 112: No. 31, 1834-8(1 Aug 1971). (In Hungarian).

In order to examine the known radiation injury of chromosomes after repeated exposure to x radiation, the chromosomes in leukocytes of 50 patients in the reproductive age group subjected to diagnostic x radiation because of sickness of the digestive tract were examined for aberrations. Each of the patients, aged 23 to 41 years, experienced at least 3 diagnostic radiographic examinations, but were not subjected to any therapeutic x-ray treatment. The man:woman ratio of the group was 27:23. During the 10-minute long fluoroscopic radiographic examination of the stomach the stomach wall is exposed to a dose of about 100 to 150 R; the gonad dose was estimated at 500 mR. In every case 50 dividing cells in the peripheral blood were examined in order to determine the occurrence of mitotic cells with chromosome anomalies. In 38.8% of the 36 cases for which the examination were completed, dicentric chromosomes, considered the most sensitive indicators of radiation injury, were observed. No chromosome anomalies were detected in the control group. In view of the potential danger of stomach x-ray examinations for the populations, it is recommended to limit them strictly; not only radiologists but clinicians requesting such examinations should be advised of this genetic risk. (TTT)

53428 STUDIES OF CHROMOSOME ABERRATIONS IN PERIPHERAL BLOOD OF ROENTGENOLOGISTS. Slowikowska, Maria G.; Grzymala, Wieslaw (State Inst. of Hygiene, Warsaw). Nukleonika; 17: No. 3-4, 241-8(1972). (In Polish).

Cytogenetic analyses were performed on peripheral leukocytes from 13 roentgenologists and 10 controls. On the basis of the results it was concluded that there was a difference between the exposed persons and the controls in occurrence of aneuploid and polyploid cells. The frequency of chromatid breaks and the rate of chromosome aberration per metaphase were clearly greater in the exposed than in the control group. (auth)

53429 RADIATION MYELOPATHY, WITH SPECIAL REFERENCE TO ITS ETIOLOGY. Ishida, Yoichi (Gunma Univ., Maebashi, Japan). Igaku No Ayumi; 80: No. 9, 555-63(Feb 1972). (In Japanese).

The etiology of radiation myelopathy is discussed in relation to the theory of circulatory necrosis, that of antigen-antibody reactions, and the cell reproductive death theory. Radiation myelopathy is a myelopathy occurring following radiotherapy of cancer when the spinal cord is included in the field of radiation and is a delayed radionecrosis of mature nervous tissues in the spinal cord. The histological picture of lesions in the spinal cord nerve cells, blood vessels, and collagen cells during radionecrosis development are described. (Japan)

53430 CLINICAL TRIALS OF RADIOSENSITIZERS AND FRACTIONATION. Revesz, L. (Karolinska Institutet, Stockholm); Scott, O. C. A. Brit. J. Radiol.; 45: No. 536, 626(Aug 1972).

The dangers of assuming that sensitization is independent of radiation dose are briefly mentioned in relation to clinical trials of Synkavit and to dose fractionation. Examples are given from experiments with O_2 or TAN. It is pointed out that it is not known whether hypoxic or anoxic foci in tumors are the greater concern in radiotherapy. Hypoxic cells have a large D_0, but are capable of recovery. On the other hand, the hypoxic cells may be eliminated as a result of reoxygenation, fully anoxic cells not being so accessible. If anoxic cells were to persist during a fractionated treatment, later giving rise to local recurrence, they might not respond to known sensitizers if combined with small fractions. (UK)

53431 RADIOBIOLOGY FORUM ON RADIOLOGICAL PROTECTION AND THE SKIN. SPECIAL REPORT No. 6. PROTECTION AGAINST IONIZING RADIATIONS. Vennart, J.; Cryer, M. A. (Medical Research Council, Harwell, Eng.). Brit. J. Radiol.; 45: No. 536, 610-20(Aug 1972).

A brief report is made of the forum under the following headings: microanatomy and thickness of the skin; radiation dose and minimal reactions in chronically irradiated skin; clinical effects of radiation; radiation induced tumors, including human experience; radiological protection of workers; and cells at risk, dose limits, and critical area. (UK)

53432 RADIATION, IMMUNITY, AND CANCER. Lancet; 2: No. 7770, 217-18(29 Jul 1972).

The effects of radiotherapy in terms of the effects on the immunological system are briefly discussed in general terms. It is pointed out that current predictions are that most human tumor cells will prove to have specific antigens on their surface. The following examples of immunological disturbance are given: analysis of the survivors of Hiroshima and Nagasaki indicated that lymphoma tended to be induced at the relatively high radiation doses affecting the body's immunity; and irradiation for therapy of mammary cancer produces a lymphopenia, reflecting a fall in the formation of lymphocytes. It is pointed out that this would diminish cell-mediated hypersensitivity reactions and the humoral antibody response to thymus-dependent antigens. (UK)

53433 TOXIC ERUPTIONS COMBINED WITH RADIATION THERAPY OF MALIGNANT TUMORS. Moriya, Hiroshi; Kaneko; Itsuo; Matsushima, Hideno; Yamada, Teruyo (Toho Univ., Tokyo). Toho Igakkai Zasshi; 18: No. 6, 925-8(Dec 1971). (In Japanese).

Three cases of skin eruptions occurring during radiation therapy of malignant tumors were reported. The cutaneous reactions developed at various periods after irradiation. Case No. 1 was a 55-year-old female with uterine cervical carcinoma, who was treated with telecobalt irradiation (^{60}Co). Spatial doses of 300 R were delivered to the 15 × 15 cm^2 field of the frontal and lateral pelvic walls alternately every day. After 9 days, mild macular eruptions occurred with a fever. Case No. 2 was a male 66 years of age with lung cancer combined with gynecomastism, who was treated with total doses of 6000 R telecobalt irradiation (^{60}Co) for 45 days. Seven days after the radiation therapy, macular eruptions accompanied with a high fever were observed. Case No. 3 was a 25-year-old female with adenocarcinoma, to whom total doses of 6000 R telecobalt irradiation were given during the treatment period totaling 45 days with intervals. Eight weeks after the therapy, mild eruptions were observed. It was considered that these reactions were caused by therapeutic irradiation. The toxic eruptions disappeared eventually, 2 to 3 months later by stopping irradiation. (Japan)

53434 DOSE TO PATIENTS FROM ROENTGENOGRAPHY. Antoku, S.; Russell, W. J.; Milton, R. C.; (and others) (Atomic Bomb Casualty Commission, Hiroshima). Health Phys.; 23: No. 3, 291-9(Sep 1972).

The roentgenological examinations reported by A-bomb survivors and their comparisons participating in the ABCC-JNIH Adult Health Study were confirmed in surveys of Hiroshima and Nagasaki hospitals and clinics. Technical exposure factors pro-

vided during the latter were used in phantom dosimetry, duplicating the examinations received by the subjects. Bone marrow integral, gonadal, and skin doses so obtained were compared with those of other investigators, and were applied to population data to estimate the magnitude of cumulated dose from medical x-ray examinations in comparison to that from the Hiroshima and Nagasaki A-bombs. (auth)

53435 EVALUATION OF EPIDEMIOLOGIC STUDIES OF LEUKEMIA AND OTHER MALIGNANCIES AFTER DIAGNOSTIC X RADIATION. Stewart, Alice; Davis, A. K.; Silverman, Charlotte (Food and Drug Administration, Rockville, Md.). pp 117-26 of Radiation Protection Standards: Quo Vadis. Vol. I. Howell, Wallace P. (ed.). Richland, Wash.; Health Physics Society (1972).

From 6th annual topical symposium on radiation protection standards: quo vadis; Richland, Wash. (2 Nov 1971).

Ninety percent of the excess radiation exposure of the population is due to diagnostic procedures and, consequently, possible biological effects of this low-level exposure are of great significance. A controversy has developed as to whether such exposures produce measurable changes in the incidence not only of leukemia but also of other malignancies. Since Stewart's original survey of all malignancies in children showed that prenatal radiation was correlated with malignant disease, this problem has been examined by several investigators. Such studies require large numbers of children, as leukemias and other malignancies are relatively rare and the dose of the few hundred millirem is unlikely to produce a large increase in the basic rate. Certain investigators have reported a correlation between diagnostic radiation exposure and an increase in malignancy, but others have been unable to substantiate this. A critical review of the past and current work in this field is presented, and an attempt is made to interpret the different findings of the several investigators. (auth)

53436 COMMENTS ON NUMERICAL VALUES FOR RADIATION EXPOSURE LIMITS. Baietti, Albert L. (International Chemical and Nuclear Corp., Irvine, Calif.). pp 452-7 of Radiation Protection Standards: Quo Vadis. Vol. II. Howell, Wallace P. (ed.). Richland, Wash.; Health Physics Society (1972).

From 6th annual topical symposium on radiation protection standards: quo vadis; Richland, Wash. (2 Nov 1971).

Personal observations are made on the use and application of numerical values for radiation exposure limits as specified by regulatory agencies. Examples are given of possible criteria that might more meaningfully reflect the relationship between radiation protection criteria and guides used or needed by operational health physicists. Particular emphasis is given to radiation exposure records and their meaning. It is suggested that present day practice may be encouraging the use of overly precise numerical values for radiation exposure measurements. (auth)

53437 IONIZING RADIATIONS AND MALFORMATIONS OF THE BRAIN. Murakami, Ujihiro (Nagoya Univ., Japan). Shinkei Kenkyu No Shinpo; 16: No. 2, 330-6(Apr 1972). (In Japanese).

Pathological effects of prenatal ionizing radiations on the developing brain and postnatal manifestations are divided into two types: the one caused by misuse of radiation treatment and the other caused by exposure to the atomic bomb, during various stages of gestation. Results of the experimental irradiation of pregnant animals during preimplantation period and stage of organogenesis, and at various stages of embryonic and fetal development, are discussed citing reference sources. The following conditions were observed frequently in animal experiments as pathological effects: stunted growth, hydrocephaly, microcephaly, microphthalmus, anencephaly, and brain stem and bone marrow anomalies. Malformations, especially those of the central nervous system, and pigmentary degeneration of the retina, cataracts, and urogenital and skeletal anomalies in children following therapeutic application of radium and x-rays during pregnancy are discussed with reference to the literature, and pathological effects of the atomic bomb explosion are reviewed. (Japan)

53438 SURGICAL TREATMENT FOR LOCAL RADIATION INJURIES FOLLOWING RADIOTHERAPY. Yasuna, Osamu; Nakamura, Kinichi; Sano, Hiroshi; Matsushita, Masamitsu; Yamazaki, Makoto (Shinshu Univ., Japan). Nippon Saigai Igakkai Kaishi; 19: No. 3, 367-72(Aug 1971). (In Japanese).

Nineteen cases of local radiation injury were examined. In patients with carcinoma of the esophagus, esophageal perforation and esophagotracheal fistula occurred during radiation therapy in which relatively small dosages of irradiation were given for a period of 2 weeks to 1 month. Esophageal perforation tended to occur during the early stage of irradiation administered for sarcoma of the stomach. The radiation injury of the small intestine tended to occur a few months or even a few years after the therapy program was completed. Chronic radiation injuries became gradually worse and tended to advance into stenosis or intestinal obstruction. Ulcer and perforation sometimes occurred from radiation injury of the blood vessels. One year after radiation therapy for uterine cancer and cancer of the rectum, fistula tended to occur either in the digestive tract or in the urinary passage. Radiation ulcers in the skin, caused by pathological changes in blood vessels as a result of mammary carcinoma therapy, tended to cause hemorrhage. Such a condition can not be cured easily. Therefore the careful observation and treatment after therapy should be continued. Use of thoracoepigastric tubes was recommended for healing the area affected by ulcer. Excessive radiation therapy should be avoided, by conducting regular biopsies to examine pathological changes. (Japan)

53439 RADIATION INDUCED HEART FAILURE. 1. ELECTROCARDIOGRAPHY FINDING. Sato, S. (Aichi Cancer Center, Nagoya, Japan); Tomita, Kazuo; Kitagawa, Toshio. Nippon Igaku Hoshasen Gakkai Zasshi; 31: No. 7, 859-64(Oct 1971). (In Japanese).

When massive doses are administered to the tumorous lesion homogeneously in the treatment field with high energy radiation, radiation damage to the heart, which is involved in the same treatment field incidentally, should be taken into consideration. In 115 cases with carcinoma of the esophagus, the heart and lungs were studied. Twenty-six cases were treated with a telecobalt unit and 89 cases underwent 6 MV x-ray treatment. They were treated with the opposing-field technique antero-posteriorly. The estimated dose to the heart was 4000 to 7000 rads in 6 to 8 weeks with the ^{60}Co unit, and 5000 to 7000 rads in 6 to 8 weeks with the 6 MV x-ray unit. Electrocardiograms (ECG) were taken during and after completion of the treatment course in conjunction with clinical observations. Appearance rate and variety of the abnormal findings of the ECG were analyzed. The following results were observed. Abnormal findings on the ECG appeared in 60% of all cases. They were found mostly at the period of the time between one and two months after completion of the treatment. Sixty percent of these improved into the normal limit in two months without any treatment. These changes were thought to be the result of acute or subacute reversible radiation reactions in the heart and they did not show any definite clinical symptoms. Irreversible changes in the remaining cases were indicative of real heart failure for clinical purposes. Not enough information was available to continue this study because the follow up of many cases in this series was not more than one year because of their progressed tumor lesions. Dose dependency in the abnormal ECG appearance was not clearly indicated. (auth)

53440 EXTRACORPOREAL IRRADIATION OF THE BLOOD. EFFECT OF VARYING TRANSIT DOSE ON THE DEGREE AND THE RATE OF DEVELOPMENT OF LYMPHOPENIA. Weeke, Eva (Rigshospitalet, Copenhagen). Acta Med. Scand.; 191: No. 5, 455-62(May 1972).

The main data of three types of equipments for extracorporeal irradiation of blood (ECIB) are presented. Results from irradiation of 80 patients are given. The average duration of ECIB was 103 hr. The mean transit dose was 295 rads and the mean total dose 42,850 rads. The lymphocyte concentration was reduced from 1,350 ± 526 before to 335 ± 122 after ECIB. The rate of development of lymphopenia was slower for patients having received significantly lower transit doses, but reduction of the lymphocyte concentration was the same for all patients. There was no correlation between flow rate, calculated as the number of patients' blood volumes irradiated per hour, and the rate of development of lymphopenia. For the patients who were not transplanted immediately, the lymphocyte concentration was followed for the next 12 months. It was shown that a prolonged lymphocyte reduction is obtained after ECIB with high transit doses. (Sweden)

53441 DNA, RNA, AND ULTRASTRUCTURAL ASPECTS OF HUMAN EPIDERMIS IN CHRONIC REACTIONS OF THE SKIN AFTER ROENTGEN IRRADIATION. Squassabia, A.; Maestro, A.; Donati, L.; Casolo, F. (Univ., Pavia, Italy). Med. Nucl.-Radiobiol. Lat.; 12: No. 3-4, 221-36(1969). (In Italian).

The ultrastructural aspects and the contents of DNA and RNA in two series of human epidermis samples taken from skin having both chronic radioatrophic and radiodermatitis aspects were studied. An increase of DNA in chronic radiodermatitis was observed. In radioatrophic skin, DNA was slightly reduced. On the electron microscope, the epidermis alterations of radioatrophic skin were prevalently observed in the nucleus. As to skin with radiodermatitis, cytoplasmatic lesions were prevalently observed. (auth)

53442 CARCINOGENESIS IN THE SURVIVORS EXPOSED TO A-BOMB IRRADIATION IN THEIR YOUTH, 1950 TO 1969. Jablon, Seymour; Tachikawa, Kiyoshi (Atomic Bomb Casualty Commission, Hirsohima). Hiroshima Igaku; 24: No. 11, 1115-19(Nov 1971). (In Japanese).

The occurrence rate of malignant neoplasms was investigated in 20,609 subjects (15,584 with irradiation; 5,025 without direct irradiation) who were under 10 yrs old and lived in Nagasaki city when the atomic bomb was dropped. Among survivors who had 100 R of irradiation at the time of bombing, there were none who had been diagnosed as having malignant neoplasms (except leukemia) before 1958. Among 1,109 survivors (at the time of Jan. 1955) who either had more than 100 R or had an unknown dosage of A-Bomb irradiation, eight died of leukemia (estimating death rate: 0.42) and eight died of other malignant neoplasms (estimating death rate: 1.1) by 1969. This statistical rate was significantly high. Furthermore, there occurred five cases of carcinoma of the thyroid (estimating occurrence rate: 2.2) and six cases of other malignant neoplasms (estimating occurrence rate: 1.3). (Japan)

53443 EXPOSURE OF RADIOLOGISTS DURING SPECIAL PROCEDURES. Riley, Richard C.; Birks, John W.; Palacios, Enrique; Templeton, Arch W. (Univ. of Kansas, Kansas City). Radiology; 104: No. 3, 679-83(Sep 1972).

During special procedures, radiologists may receive substantial radiation exposure, especially to the unprotected lens of the eye: 92% of a radiologist's exposure at arteriography is due to radiography at the time of contrast medium injection. The mean lens exposure per exam is 5.8 mR for cerebral and 27.1 mR for abdominal arteriograms. Unshielded by the lead apron, a front-collar film badge overestimates lens exposure by 20% for cerebral and underestimates by 20% for abdominal arteriograms. Since most exposure occurs during contrast medium injection, manual injection should be avoided whenever possible. (auth)

53444 RETINAL AND OPTIC NERVE COMPLICATIONS IN A HIGH DOSE IRRADIATION TECHNIQUE OF ETHMOID SINUS AND NASAL CAVITY. Shukovsky, Leonard J.; Fletcher, Gilbert H. (Univ. of Texas, Houston). Radiology; 104: No. 3, 629-34(Sep 1972).

Thirty patients with tumor of the ethmoid sinus and nasal cavity were treated with megavoltage irradiation. High doses were delivered to the tumor and adjacent retina and optic nerve. Eighty-seven per cent of the squamous cell carcinomas were locally controlled and 67% of the patients were alive and free of disease at four years or more. The clinical and funduscopic changes associated with radiation injury of the retina and optic nerve include macular and retinal degeneration, optic nerve atrophy, central artery thromboisis, and blindness. Damage to the retina and optic nerve is correlated with a time-dose response curve. (auth)

53445 CHROMOSOME ABERRATIONS INDUCED IN HUMAN BONE-MARROW CELLS BY THERAPEUTICAL LOCAL γ IRRADIATION: TIME AND DOSE RELATIONSHIPS. Pyatkin, E. K.; Alexsandrov, N. N.; Vorobev, A. I.; Petrova, S. A.; Suskov, I. I. (Inst. of Biophysics, Moscow). Mutat. Res.; 16: No. 1, 103-9 (Sep 1972).

Bone-marrow cell chromosome aberrations were studied in 14 unirradiated control patients with malignant tumors and 132 comparable patients after a single localized exposure to ^{60}Co γ irradiation. In control patients, the chromosome break frequency was 0.01 per cell and aberrant cell frequency was 1.1%. In 79 patients, the dependence of chromosome aberrations on the time interval after irradiation following a dose of 250 rad was studied. The highest frequency of aberrant cells was observed 18 and 21 hr after a single irradiation (about 65%). It was shown that the number of chromosome aberrations in cells entering mitosis soon after irradiation (apparently the G_2 cells) was much greater (438.1 aberrations per 100 cells) than that in cells entering mitosis in other periods. A sharp decrease in the number of aberrant cells and aberrations was observed 72 and 96 hr after irradiation, and especially at 120 and 168 hr. In 67 patients, the relation between dose and chromosome aberration yield was studied. It was shown that the yield of chromosomally aberrant cells increases linearly with dose, according to the equation $Y = 6.385 + 0.195 \cdot D$. (auth)

53446 NEUROPATHOLOGIC EFFECTS OF PROTON-BEAM IRRADIATION IN MAN. II. EVALUATION AFTER PITUITARY IRRADIATION. Nielsen, S. L.; Kjellberg, R. N.; Asbury, A. K.; Koehler, A. M. (Massachusetts General Hospital, Boston). Acta Neuropathol.; 21: No. 1, 76-82(1972).

Neuropathological material from eight patients hypophysectomized by proton-beam irradiation was studied. In no instance was radiation damage to the brain clinically evident. However, in the brains of five of these patients, small radionecrotic lesions were found in the medial temporal lobes and hypothalamus, and the extent of pituitary necrosis was documented. Possible pathogenic factors in the development of lesions in these areas of the brain are briefly discussed. (auth)

Vertebrates

Refer also to abstracts 53512 and 54871.

53447 (CONF-720822-2) RADIATION-INDUCED HEMOPOIETIC LESIONS IN FISH. Cosgrove, G. E.; Blaylock, B. G.; Ulrikson, G. U. (Oak Ridge National Lab., Tenn.); Cohan, P. C. (Cooperative Science Education Center, Inc., Oak Ridge, Tenn.). [nd]. 23p. Dep. NTIS.

From Symposium on fish pathology; Washington, D. C. (7 Aug 1972).

Radioinduced changes in hematopoietic tissues of some 13 species of native and aquarium reared fish were studied following acute or chronic exposure to various doses and dose rates of γ radiation. Acute irradiation induced hemopoietic damage to a greater extent than did chronic or fractionated dose irradiation, even when massive doses were accumulated. A bibliography on hematopoiesis in fish is included. (C.H.)

53448 (COO-1332-78) EFFECTS OF RADIATION ON THE BEHAVIOR OF ANIMALS: A REVIEW OF THE LITERATURE. Appendix to 1972 Progress Report. Preston, J. L. (Minnesota Univ., Minneapolis). 1972. Contract AT(11-1)-1332. 66p. Dep. NTIS.

A review of the literature on effects of radiation on the behavior of animals is presented. The following aspects of behavior were investigated: detection, arousal, and activity changes; orientation; feeding; emotionality; social behavior; reproductive behavior; learning and performance; discrimination learning; maze learning; distractibility; avoidance conditioning; prenatal irradiation effects; aging effects; and genetic effects. (approximately 400 references) (H.L.W.)

53449 (COO-3017-4) RENAL TUMORS IN PARABIOSED IRRADIATED RATS. Warren, Shields; Brown, Clark E.; Porter, Marilyn W. (New England Deaconess Hospital, Boston, Mass. Cancer Research Inst.). [nd]. Contract AT(11-1)-3017. 19p. (CONF-720530-5). Dep. NTIS.

From 20th annual meeting of the Radiation Research Society; Portland, OR. (14 May 1972).

Ninety-five (7.6%) irradiated partners of 1244 parabiosed rats receiving 1000 R of whole-body irradiation developed renal tumors, 10.3% of the males and 5.2% of the females. The commonest types of renal tumors were renal cell carcinomas, adenomas and transitional cell carcinomas. As with irradiation carcinogenesis in general, renal tumors in irradiated rats appear earlier and with greater frequency than spontaneous tumors in nonirradiated rats. The nonneoplastic renal tubular epithelium of the irradiated tumor-bearing kidneys contained fewer mitoses than the renal tubular epithelium of their nonirradiated partners. (auth)

53450 (LA-4874, pp 126-44) SWINE SKIN CHANGES PRODUCED BY DIFFERENT RADIATIONS. Archambeau, John O. (Nassau County Medical Center, East Meadow, N. Y. (USA)). Mar 1972.

From fifth LAMPF users meeting; Los Alamos, NM. (8 Nov 1971).

Studies were conducted on quantification of gross and histologic skin changes produced by increasing absorbed dose increments of different radiations and different time-dose schedules. Cell kinetics of the irradiated epidermal cell population were identified and quantified. The evolution, time course, and dose dependence of the reactions produced by absorbed doses of x rays, thermal neutrons, fission neutrons, the $^{10}B(n,\alpha)^7Li$ reaction, and multiple exposures to x ray were quantified. Variations in the epidermal population and other histological and cytologic changes of the epidermis and dermis were quantified following single absorbed doses of x ray and the $^{10}B(n,\alpha)^7Li$ reactions. Basal cell x ray dose-survival estimates were made. A model of the skin response was developed for making comparisons with the observed results. (H.L.W.)

53451 (NASA-TM-X-2440, pp 622-32) FACTORS MODIFYING THE RESPONSE OF LARGE ANIMALS TO LOW-INTENSITY RADIATION EXPOSURE. Page, Norbert P. (National Cancer Inst., Bethesda, Md.); Still, Edwin T. Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

In assessing the biological response to space radiation, two of the most important modifying factors are dose protraction and dose distribution to the body. Studies are reported in which sheep and swine were used to compare the hematology and lethality response resulting from radiation exposure encountered in a variety of forms, including acute (high dose-rate), chronic (low dose-rate), combinations of acute and chronic, and whether received as a continuous or as fractionated exposure. While sheep and swine are basically similar in response to acute radiation,

their sensitivity to chronic irradiation is markedly different. Sheep remain relatively sensitive as the radiation exposure is protracted while swine are more resistant and capable of surviving extremely large doses of chronic irradiation. This response to chronic irradiation correlated well with changes in radiosensitivity and recovery following an acute, sublethal exposure. Swine recover remarkably fast and develop a large and persistent radioresistance. The change in radiosensitivity of sheep after either acute or chronic sublethal exposure is basically the same, consisting of a triphasic pattern of an initial slow recovery, transient radioresistance and regression into a long-lasting period of relative radiosensitivity. The overall effect of receiving both acute and chronic exposures within a short period of time may depend upon the sequence of the exposures. In addition to protraction, spatial or body distribution is a significant factor in the response of large animals to radiation exposure. (auth)

53452 (NASA-TM-X-2440, pp 633-40) EFFECT OF CONTINUOUS GAMMA-RAY EXPOSURE ON PERFORMANCE OF LEARNED TASKS AND EFFECT OF SUBSEQUENT FRACTIONATED EXPOSURES ON BLOOD-FORMING TISSUE. Spalding, J. F.; Holland, L. M.; Prine, J. R.; Farrer, D. N.; Braun, R. G. (Los Alamos Scientific Lab., N. Mex.). Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

Sixteen Macaca mulatta monkeys trained to perform continuous and discrete-avoidance and fixed-ratio tasks with visual and auditory cues were performance-tested before, during, and after 10-day gamma-ray exposures totaling 0, 500, 750, and 1000 rads. Approximately 14 months after the performance-test exposures, surviving animals were exposed to 100-rad gamma-ray fractions at 56-day intervals to observe injury and recovery patterns of blood-forming tissues. The fixed-ratio, food-reward task performance showed a transient decline in all dose groups within 24 hrs of the start of gamma-ray exposure, followed by recovery to normal food-consumption levels within 48 to 72 hrs. Avoidance tasks were performed successfully by all groups during the 10-day exposure, but reaction times of the two higher dose-rate groups in which animals received 3 and 4 rads per hour or total doses of 750 and 1000 rads, respectively, were somewhat slower. Performance of reward and avoidance tasks was equal to control levels 60 days after termination of gamma-ray exposures, showing no residual neurological injury reflected as a decrement in motivation to perform learned tasks. Peripheral blood characteristics showed dose-dependent injury to blood-forming tissue. Radiation-induced injury in higher dose groups reached critical levels, resulting in death of three subjects. During a 60-day recovery period, peripheral blood elements returned to control levels. During the fractionated gamma-ray exposure regime, initiated 414 days after the performance-test exposures, bone-marrow suppression was observed after each 100-rad exposure. Recovery to pre-exposure levels was observed in all groups during each 56-day recovery period between exposures. All animals in each of the four pre-test dose groups were vigorous, active, and aggressive after fifteen 100-rad fractions, and the bone marrow of each group was sufficiently resilient to maintain animals in a clinically healthy condition. (auth)

53453 (NASA-TM-X-2440, pp 641) RELATIVE BIOLOGICAL EFFECTIVENESS OF FAST NEUTRONS COMPARED WITH X RAYS: PRENATAL MORTALITY IN THE MOUSE. Friedberg, W. (Federal Aviation Administration, Oklahoma City, Okla); Hanneman, G. D.; Faulkner, D. N.; Darden, E. B. Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

The effects of fast neutrons on mouse zygotes were investigated. Virgin female mice were mated and then exposed to fast neutrons or x rays while the zygotes were still in the pronuclear stage. Sixteen days after irradiation, the mice were killed and the uteri dissected. The number of dead embryos, live embryos, and gross anomalies was recorded. The relative biological effectiveness of fast neutrons, in comparison to x rays, for inducing prenatal mortality in mice was determined. (E.R.B.)

53454 (NASA-TM-X-2440, pp 642-6) PROTON IRRADIATION OF STEM CELLS: RADIATION DAMAGE AND CHEMICAL RADIOPROTECTION. Riley, Richard C.; Montour, James L.; Gurney, Clifford W. (Univ. of Kansas, Kansas City. Medical Coll. of Virginia, Richmond). Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

Although many systems for studying radiobiological effects of high energy protons are available, much work has utilized whole mammals as the test system. Cellular level studies in mammals have included characterization of hematopoietic sequelae of total body exposure. In this study the effects of high energy protons on erythropoietic stem cells (erythropoietin responsive cells) and radioprotection by chemical agents have been measured. The facilities of the NASA Space Radiation Effects Laboratory, Newport News, Virginia, were used. Carworth Farms CF-1 mice were exposed (five in tandem) to a parallel beam of 600 MeV protons. The fluence distribution was determined by ^{11}C foil counting. The fluence, when converted to dose, was referenced to the synchrocyclotron beam monitors that were then used to administer radiation exposures. Mice were given graded doses to 300 rads to determine the dose-response curve. Other mice received saline, AET, or 5-hydroxytryptamine 10 to 15 min before irradiation. All mice received six units human urinary erythropoietin on day 2 following exposure, 0.5 μCi ^{59}Fe on day 4, and were killed on day 7. Percent iron incorporation was then determined as a measure of the fraction of stem cells remaining. Preliminary experiments, carried out as described, show a dose-response curve similar to that obtained with 250 kV x rays indicating an RBE of approximately one. Chemical radioprotection can be shown under these conditions for both AET and 5-HT with doses well below the LD_{50} dose. Under the conditions of these experiments AET and 5-HT are equally effective and a dose reduction factor of 2.5 is obtained. The specification of radiation tolerance doses for manned space missions requires quantitative information from sub-lethal doses. These experiments indicate that the stem cell system can be further utilized to obtain such information. (auth)

53455 (NASA-TM-X-2440, pp 647-51) RADIATION CARCINOGENESIS AND ACUTE RADIATION MORTALITY IN THE RAT AS PRODUCED BY 2.2-GeV PROTONS. Shellabarger, C. J.; Straub, R. F.; Jesseph, J. E.; Montour, J. L. (Univ. of Michigan, Ann Arbor. Brookhaven National Lab., Upton, N. Y.). Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

The Brookhaven National Laboratory Cosmotron was used to produce 2.2 GeV protons for whole-body exposure of young, female Sprague-Dawley rats. A single exposure of 42-day old rats to 92 rads of protons produced a mammary neoplastic response over a 365-day period that was qualitatively and quantitatively similar to the response produced by 158 rads of ^{60}Co gamma rays. When the two types of radiation exposures were combined they appeared to produce an additive mammary neoplastic response. Because of the qualitative similarity of the mammary neoplastic response to the two types of radiation and because the two types of radiation appeared to be additive, it was suggested that 2.2 GeV protons act by a mode of action that is similar to that of low LET radiation. Acute radiation mortality produced by a single exposure of 42-day old rats to protons was qualitatively similar in terms of mean survival time to mortality produced by ^{60}Co gamma rays. It was suggested that 2.2 GeV protons act to produce acute radiation mortality in a fashion similar to that of low LET radiation. The administration of a radioprotective drug, AET, to 36-day old rats produced a small decrease in radiation mortality and a small increase in mean survival time when the drug was given before exposure to 2.2 GeV protons. This result was taken to mean that 2.2 GeV protons act at least in part as low LET radiation. Although exact RBE values could not be determined for acute mortality and carcinogenesis in the young rat, approximate values appear to be 1.4 and 1.5. (auth)

53456 (NASA-TM-X-2440, pp 652-8) RESPONSE OF MOUSE EPIDERMAL CELLS TO SINGLE DOSES OF HEAVY PARTICLES. Leith, J. T.; Schilling, W. A.; Welch, G. P. (Univ. of California, Berkeley). Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

The survival of mouse epidermal cells to heavy-particles was studied in vivo by the Withers clone technique. Experiments with accelerated helium, lithium, and carbon ions were performed. The survival curve for the helium ion irradiations used a modified Bragg curve method with a maximum tissue penetration of 465 microns, and indicated that the dose needed to reduce the original cell number to 1 surviving cell/cm^2 was 1525 rads with a D_0 of 95 rads. The LET at the basal cell layer was 28.6 keV/micron. Preliminary experiments with lithium and carbon used treatment doses of 1250 rads with LET's at the surface of the skin of 56 and 193 keV/micron, respectively. Penetration depths in skin were 350 and 530 microns for the carbon and lithium ions whose Bragg curves were unmodified. Results indicate a maximum RBE for skin of about 2 using the skin cloning technique. An attempt has been made to relate the epidermal cell survival curve to mortality of the whole animal for helium ions. (auth)

53457 (NASA-TM-X-2440, pp 659-64) LYMPHATIC INVOLUTION AND EARLY MORTALITY IN THE YOUNG CHICKEN PRODUCED BY 2.2-GeV PROTONS. Montour, James L.; Shellabarger, Claire J. (Virginia Commonwealth

Univ., Richmond. Univ. of Michigan, Ann Arbor. Brookhaven National Lab., Upton, N. Y.). Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

Young single-comb white Leghorn cockerels were subjected to single acute doses of either 2.2 GeV protons or 250 kVp x rays. Since young chickens exposed in the lethal range die within 48 hrs of exposure, an hourly tabulation of deaths was recorded for this length of time after exposure. Animals that were exposed to sublethal doses were killed five days after exposure and their major lymphatic organs (thymus, bursa, and spleen) removed and weighed. In the lethal range, animals exposed to 2.2 GeV protons died sooner than those receiving similar doses of x rays, but total mortality was similar in each case at similar dose levels. The 48 hr LD_{50} was determined to be 710 rad. Measured five days after exposure, 50% depression (ED_{50}) for lymphatic organs occurred as follows: thymus, 350 rad; bursa 500 rad; spleen 450 rad. In all cases, RBE values were not different from unity. The total dose from protons of this energy is comprised of a low LET portion due to dE/dx energy loss and a high LET portion due to nuclear interactions. RBE values considerably below unity would be predicted on the basis of dE/dx energy loss alone. It is suggested then, that the RBE of that portion of the dose contributed by nuclear interactions is very high. If high LET interactions account for only 5% of the total dose, then these interactions could have an RBE great as 7. (auth)

53458 (NASA-TM-X-2440, pp 665-71) EVALUATION OF THE HAZARD FROM EXPOSURE TO ELECTRON IRRADIATION SIMULATING THAT IN THE SYNCHRONOUS ORBIT. Lippincott, Stuart W.; Foelsche, Trutz; Montour, James; Bender, Roger; Wilson, John (Virginia Commonwealth Univ., Richmond. Langley Research Center, Hampton, Va. The Citadel, Charleston, S. C.). Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

The electron spectrum predicted for the synchronous orbit was simulated to determine the effects that might occur to astroscientists exposed to such irradiation while on a prolonged space station mission in that region. Miniature swine were exposed to monoenergetic and spectral-fractionated irradiations with 0.5 to 2.1 MeV electrons. Clinical and pathological alterations observed in biopsies were correlated with depth-dose pattern and length of post-irradiation period up to one year. With monoenergetic electrons, the lowest dose causing a recognizable lesion was 1450 rad and with increasing dose lesions appeared earlier and were more severe. At the highest dose given, 2650 rad, ulceration extending into the dermis was present by twenty-one days and required about four months for complete healing. Spectral-fractionated irradiations, in which the total dose range was essentially comparable to that of the monoenergetic series, resulted in very minimal outer dermis edema at 1790 rad and at no dose employed did necrosis of epidermis or ulceration into dermis occur. (auth)

53459 (NP-19403) APPLICATION OF ATOMIC ENERGY IN AGRICULTURE. Annual Report, 1971. (Instituut voor Toepassing van Atoomenergie in de Landbouw, Wageningen (Netherlands)). 1972. 153p. Dep. NTIS (U. S. Sales Only).

The research was carried out at the Association's Institute in Wageningen and at other institutes in Belgium, Germany, Italy, and the Netherlands. Results of the following scientific studies are reported: applications and methodology in mutation breeding; chemical, physical, and ontogenetic factors in radiation genetics; related genetic studies; related in vitro studies; radiation preservation of food; radiation genetics of insect pests; uptake of specific elements by plants; movement of specific elements and water in soils; and related physical studies. Practical applications, courses, and services are also discussed. (H.L.W.)

53460 (SZS-132) STATE AND TENDENCIES OF CHEMICAL PROTECTION AGAINST IONIZING RADIATION. A Literature Survey 1970/71. Fischer, H.; Siegel, G.; Haehn, J.; Tapp, E.; Scheefeld, E. (Staatliche Zentrale fuer Strahlenschutz, Berlin (East Germany)). Jun 1972. 52p. (In German). Dep. NTIS (U. S. Sales Only).

Summaries are presented of 309 papers published in 1970 and 1971 on chemical protection against radiation. Protection studies in vitro and in vivo, the biochemical and pharmacological effects of radioprotective agents, and the trends in this field of research are described. (auth)

53461 (UCB-34-P-82-13) ELECTROPHYSIOLOGICAL AND BIOCHEMICAL STUDIES OF THE EFFECTS OF RADIATION ON BRAIN ACTIVITY AND DEVELOPMENT. Progress Report, August 1971-31 July 1972. Timiras, Paola S. (California Univ., Berkeley). 1 Aug 1972. Contract AT(04-3)-34. 41p. Dep. NTIS.

Previous studies demonstrated that the enzymes of acetylcholine metabolism are affected by neonatal x radiation. These alterations depend upon the stage of development of the CNS structure at the time of irradiation as well as the applied dose. Extended studies in rats showed that the increase observed in AChE and ChAc activity are accompanied by changes in ACh content. The activity of other enzymes was also investigated in order to clarify whether the enzymes of acetylcholine were affected specifically or whether other enzymes, similar in their distribution and localization in the CNS, were also affected. Efforts to assess the mode of action by which neonatal x radiation alters cholinergic neurotransmission pointed to two possible mechanisms: imbalances between cholinergic and noncholinergic neurons, and/or the malformation of their synaptic arborization. Studies of the effects of x radiation on the adult rat CNS also indicated changes in acetylcholine content of the cerebral hemispheres; however, the effects are the reverse of those observed in the developing organism and are not accompanied by changes in the enzymes associated with ACh synthesis or hydrolysis. In the rat, as in other mammals, each brain area showed a characteristic maturational pattern, evidenced also with respect to the development of the cholinergic system. (C.H.)

53462 (UR-3490-183) SEQUENTIAL PATHOPHYSIOLOGY OF IONIZING RADIATION ON THE BEAGLE THYROID GLAND. Lu, Shin-tsu; Michaelson, Sol M.; Quinlan, William J. (Rochester Univ., N. Y. Dept. of Radiation Biology and Biophysics). 1971. 60p. Dep. NTIS.

Response of the thyroid gland to external ionizing radiation exposure may manifest itself in a temporal manner, functionally, by transient increased activity, and progressive hypothyroidism and pathologically, by degeneration, hyperplasia, and carcinogenesis. Although such derangements have been characterized in animals and man, the pathogenesis and mechanism of the reaction have not been elucidated. Using the dog as an experimental model, evidence has been obtained which indicates vascular alteration may initiate and amplify the visible and functional thyroid derangement. Increase in circulating TSH appears to be secondary to the glandular damage and TSH also appears to be the promoting factor not only in progressive changes and its self-perpetuation, but also in the sequence of events leading to permanent hyperplasia or carcinogenesis. The post-irradiation latency for induction of thyroid neoplasia in the dog (4 to 10 years), man (9 to 14 years), and the rat (1 to 2 years) shows a linear relationship with basal metabolic rate. Although this relationship may be fortuitous, it may be indicative of a fundamental factor related to tissue metabolism and thyroid cell turnover rate. (auth)

53463 SODIUM TURNOVER IN IRRADIATION HYPERTENSION. Ermel, A. E. (Univ., Louvain, Belgium). Clin. Sci.; 43: No. 2, 219-32(Aug 1972).

Changes in sodium turnover in experimental hypertension were studied by tracer kinetic methods after injection of the long-lived radioisotope ^{22}Na. In rats treated with renal irradiation, the prehypertensive latent period is characterized by a modified distribution of body sodium that can be interpreted as a transfer from peripheral stores to a more centrally located pool. Before the development of hypertension, the rapidly exchangeable sodium increased by 14%. The rise in blood pressure to a hypertensive level is associated with a decrease in the fractional excretion rate of sodium. During the established phase of hypertension, serial determinations of exchangeable sodium indicate rapidly fluctuating shifts of body sodium, the significance of which remains unknown. (auth)

53464 ACUTE EFFECTS OF IONIZING RADIATION ON ANTIBODY-PRODUCING CELLS (PFC) IN MOUSE SPLEEN DURING PRIMARY AND SECONDARY RESPONSES TO SHEEP ERYTHROCYTES (SRC). Harris, G.; Sljivic, V. (St. Mary's Hospital Medical School, London). Immunology; 23: No. 2, 147-58(Aug 1972).

The acute effects of various doses of whole-body x radiation over a dose range 0 to 1000 R on the splenic antibody-producing cells (PFC) of mice responding to primary and secondary immunization with sheep red cells (SRC) were studied. The results showed that suppression of plaque-forming capacity occurred 2 hr after varying doses of x rays and was very severe by 6 hr. No differences in sensitivity were seen at any stage of primary or secondary response examined. This acute depressive effect showed that the maintenance of splenic PFC was highly sensitive to radiation and was associated with a severely reduced uptake of ^{3}H-thymidine into the spleen at the same time after irradiation. Since previous studies [Harris and Pelc, Immunology, 19, 865 (1970)] have shown that incorporation of ^{3}H-thymidine occurred in non-dividing cells in mouse spleen, it was concluded that this turnover of DNA was important for the development of the capacity of cells to produce specific antibodies and that the acute depres-

sive effects of x radiation on splenic PFC were primarily due to inhibition of this process. (auth)

53465 BALNEOTHERAPY EFFECTS ON MICE IRRADIATED WITH MIXED FAST NEUTRONS AND GAMMA RAYS. Arima, Masashi (Kyushu Univ., Beppu, Japan). Onken Kiyo; 23: No. 1, 57-78(Mar 1971). (In Japanese).

Six groups of mice were irradiated with the mixed irradiation composed of 200 rads fast neutrons and 300 R γ rays simulating the radiation produced by atomic bomb explosion. Each group of animals thus irradiated was subjected to daily thermal bathing in one of the following types of spring water for 20 successive days — Umijigoku (NaCl containing acidic water), Yanagi (simple thermal), Genbaku-center spring (simple thermal), modified thermal (added with sulphur and cobalt), and tap water bathing. One group served as a non-treated control. Recovery from body weight loss was fast in the Umijigoku group, and recovery of circulating erythrocyte count was fast in the thermal bathing groups. The Genbaku-center and modified thermal groups did not show any decrease in hemoglobin content, while in the other groups, hemoglobin content decreased markedly. Recovery from circulating leukocyte decrease in the modified thermal and Genbaku-center bathing groups was remarkable. Histologic examination of spleens showed accelerated recovery from change caused by the irradiation in the modified, Yanagi, and Genbaku-center bathing groups. These results seem to show that bathing in thermal springs is beneficial for promoting recovery from the radiation disturbance caused by the mixed irradiation of fast neutrons and gamma rays. Of the springs examined, the Genbaku-center thermal and modified simple thermal gave the best result in general. (Japan)

53466 RADIOSENSITIVITY OF CIRCULATING HEMOPOIETIC STEM CELLS (CFU). Duplan, J. F.; Mazurek, C. (Institut du Radium, Paris). Compt. Rend. Soc. Biol.; 165: No. 7-8, 1542-5 (1971). (In French).

Certain hemopoietic stem cells (CFU) possess the ability to provide microscopically visible spleen nodules when transplanted intravenously into isogeneic mice having received a 100% lethal dose of x rays. This technique demonstrates that the radiosensitivity of the cells varies with the organs from which they originate: fetal liver, bone marrow, or spleen. It is also noticed that the cell strains of the peripheral blood are significantly more radiosensitive than those of the hemopoietic organs. (France)

53467 ULTRASTRUCTURE CHANGES IN THE ADENOHYPOPHYSIS OF RODENTS AFTER TOTAL OR SEGMENTARY IRRADIATION WITH RADIOCOBALT. Theret, C. G.; Lavedan, Jacques; Lalegerie, Pierre; Comlan, Guy. Compt. Rend. Soc. Biol.; 165: No. 7-8, 1546-9(1971). (In French).

The cell sensitivity to radiolesions was observed in relation to the trophine of the gland studied. Positive PAS cells are more sensitive than negative PAS cells above all in the gonadotropes even when the gonads are protected or at rest. This sensitivity exists also for the thyreotropes. The ultrastructural mechanisms explaining the lesions and the distribution of endocrine cells in the adenohypophysis are the same as those explaining the physiological or pathological excitation of hormone secretion. (France)

53468 FUNCTION OF THE RETICULOENDOTHELIAL SYSTEM IN WHOLE-BODY IRRADIATED MICE. Schildt, B. E.; Eriksson, K.-H. (Foersvarets Forskningsanstalt, Stockholm). Acta Radiol., Ther., Phys., Biol.; 11: No. 1, 48-58(Feb 1972).

The influence of whole-body roentgen irradiation on the function of the reticuloendothelial system was investigated in mice by determining the phagocytic index for and tissue localization of ^{51}Cr-labeled xenogenic erythrocytes injected intravenously. Exposure to LD_{10} reduced the phagocytic capacity significantly within 7 days, while the same effect was evident as early as 1 day after LD_{50}. Sublethal exposure ($0.5 \times LD_{10}$) failed to affect phagocytosis to any degree. Possible explanations for the impaired capacity after irradiation are discussed. (auth)

53469 EFFECTS OF HIGH INTENSITY PULSED X-RAY (LINEAR ACCELERATOR) OR GAMMA-RAY IRRADIATION UPON TUMORIGENESIS AND IMMUNOCOMPETENCE IN MICE. Imamura, Nobutaka; Nakano, Mimako; Takizawa, Shoichi; Yokoro, Kenjiro (Hiroshima Univ.). Hiroshima Igaku; 24: No. 11, 1074-84(Nov 1971). (In Japanese).

Whole-body irradiation was carried out by Linac 25 MV x-ray with 670 to 850 rads on female ICR/JCL mice of 10 weeks. Within 360 days after irradiation, the mean rate of occurrence of leukemia was 30.3%, and increased to 39.3% by irradiation of ^{60}Co gamma ray with 750 to 950 rads. Female ICR/JCL mice of 3 months were sensitized with sheep erythrocytes before and after irradiation by Linac x-ray with 730 rads. Numbers of plaque forming cells (PFC) in the spleen were measured on the 4th day after irradiation. The number of PFC in the immune group after irradiation was decreased more than that in the group before irradiation. Female ICR/JCL mice of 3 months were irradiated by whole-body irradiation with 100 through 500 rads of Linac x-ray and ^{60}Co gamma-ray. One day after irradiation, these mice were sensitized with sheep erythrocytes and the number of PFC in the spleen was measured on the 4th day. Up to a dose of 200 rads, no change was observed, but above 200 rads the number of PFC decreased abruptly for both Linac x-ray and ^{60}Co gamma-ray exposures. The same type of change was observed in the values of plasma hemolysin and of hemagglutinin. There were no particular differences in tumorigenesis and immunocompetence between irradiations by linear accelerator and by ^{60}Co gamma-ray, except that there existed some possibility of RBE on hematopoietic reactions and immune responses by high intensity pulsed x-ray (Linear accelerator). (Japan)

53470 CHROMOSOMAL AND HISTOLOGICAL CHANGES IN EMBRYOS EXPOSED TO 14.1 MeV FAST NEUTRONS. Shimada, Katsunobu (Hiroshima Univ.). Med. J. Hiroshima Univ., 19: No. 3-4, 59-81(Apr 1971). (In Japanese).

Chromosomes of rat embryo were examined by the direct method, and serial sections were observed histologically. After a short time of mitotic arrest following irradiation, unstable types of aberrations increased, and then decreased gradually with time. At 72 hrs after irradiation, unstable types disappeared. On the other hand, stable types of aberrations appeared 4 hrs after irradiation, and continued until 120 hrs, although the incidence was low. Aneuploid cells, especially hypodiploid cells, increased shortly after irradiation, and then gradually decreased to the control level. Polyploid cells appeared during the period of 48 to 120 hrs after irradiation, though the incidence was low. Abnormal chromosomes showed type specificity, i.e., most frequently in the telocentric type, less frequently in the sub-telocentric, and rarely in the meta-centric. Cell damages were remarkable during 3 to 4 hrs after irradiation, followed by the repair process of the embryonic structures during the periods of 6 to 12 hrs following irradiation. At 24 hrs after irradiation, degeneration products disappeared from the surroundings of the embryo, and mitoses became remarkable. However, retardation and abnormal differentiation were observed in the embryo. From the radiobiological viewpoints, embryonic responses to the radiation were different among dermal tissues. Mesoderm and cylindrical cell-lined entoderm were relatively tolerant to the fast neutrons. These results suggested that direct cell damage and repair errors might be involved in teratogenesis. (Japan)

53471 MALFORMATION OF DIGITS IN MOUSE FOETUS CAUSED BY GAMMA-RAY IRRADIATION DURING PREGNANCY. Ueka, Keiko; Yoshizawa, Yasuo (Tokyo Univ.). Nippon Igaku Hoshasen Gakkai Zasshi; 30: No. 11, 107-15(Feb 1971). (In Japanese).

The development of digital malformations and their usefulness as biological indicators of radiation effects were studied. The experimental animals used were the ddY strain of mice, 70 days old. After keeping for a week, the esterus mice were kept with males in cages overnight and the next morning those found with vaginal plugs were considered to be in day zero of pregnancy. The pregnant mice were exposed to the gamma ray of cesium-137. The pregnant mice were irradiated with 200 R of γ rays (dose rate, 3.3 R/min) at different stages of gestation between 8 and 13 days after fertilization. The mice were irradiated at the six different dose-rates of 1.0, 3.3, 6.7, 20, 40, and 100 R/min (total exposure dose, 200 R) on the 11th day of pregnancy. The mice were irradiated with the six different doses of 75, 100, 150, 200, 250, and 300 R on the 11th day of pregnancy. On the 18th day of pregnancy, the fetuses were removed from sacrificed mothers, and were observed for digital malformations (Ectrodactylism, Brachydactylism, Polydactylism, and Syndactylism) and body weight. The critical period for the digital malformations was found on the 11th day of pregnancy. The dose-effects relationship of the digital abnormal development showed that the threshold dose existed between 75 and 100 R, and the appearance rate of the malformations reached about 100% at the dose of 250 R. An inverse correlation was found between digital abnormality and fetus weight. In fetuses irradiated at lower doses and dose rates, malformations appeared in two forelimbs, and at higher doses and dose rates they appeared in all digits. The malformations of only hindlimbs, one digit or three digits, were rare. The dose-rate dependencies were found both in the abnormality and body weight. (auth)

53472 DOSE RATE DEPENDENCE IN THE GOITROGEN STIMULATED MOUSE THYROID. A COMPARATIVE INVESTIGATION OF THE EFFECTS OF ROENTGEN, ^{131}I, AND ^{133}I IRRADIATION. Walinder, G.; Jonsson, C.-J.; Sjoeden, A.-M. (Foersvarets Forskningsanstalt, Stockholm). Acta Radiol., Ther., Phys., Biol.; 11: No. 1, 24-36(Feb 1972).

The doses of radiation necessary to inhibit goitrogen stimulated thyroid growth in the CBA mouse are much lower after roentgen exposure than those needed to produce the same effects after ^{131}I administrations. Similar differences in the "ef-

fectiveness" of the two types of radiation have been observed in several different animals as well as in man. A comparison of the dose-effect relationships after irradiation of the mouse thyroid with roentgen rays, ^{131}I, and ^{132}I has shown that the difference in the "effectiveness" of the three types of radiation largely consists of a dose rate effect. Inhomogeneities in the distribution of the ^{131}I-dose, and effects on the perithyroidal tissue produced by external irradiation, are of little significance in this connection. (auth)

53473 BIOLOGICAL DOSIMETRY USING BONE MARROW SAMPLES. Segreto, Camilo; Ludwig, Frederic (Univ. of California, Irvine). Compt. Rend., Ser. D; 274: No. 18, 2610-12 (3 May 1972). (In French).

A positive correlation exists between the erythrocyte/nucleated cell ratio and the radiation dose absorbed by the bone marrow of animals subjected to whole-body irradiation. The ratio (contrary to the absolute number of erythrocytes or the number of nucleated bone marrow cells) can be determined from medulla (samples having unknown and variable volumes). This biological dosimetry method was applied to experiments with laboratory mice. (France)

53474 IDENTIFICATION OF THE CELL POPULATION RESPONDING TO DNP-GL IN LETHALLY IRRADIATED STRAIN 13 CHIMERIC GUINEA PIGS RECONSTITUTED WITH STRAIN 13 BONE MARROW AND (2 x 13) F_1 LYMPH NODE AND SPLEEN CELLS. Ellam, Leonard; Green, Ira; Benacerraf, Baruj (National Institutes of Health, Bethesda, Md.). Cell. Immunol.; 1: 445-54(Oct 1970).

The ability of guinea pigs to make an immune response to synthetic polypeptides (DNP-GL) was successfully transferred to lethally irradiated, nonresponder strain-13 guinea pigs protected with syngeneic bone marrow and immunologically reconstituted with lymph node and spleen cells. An analysis of the origin of the lymphoid cells involved in anti-DNP antibody production and antigen-mediated stimulation of lymph node cells in vitro was performed in the chimeric animals. It was found that both functions depended entirely on the presence of the donor cells. (auth)

53475 PROTECTIVE EFFECT OF CYSTEAMINE AT FRACTIONATED IRRADIATION. 3. HISTOPATHOLOGIC DIAGNOSES AT DEATH. Nelson, A.; Jaerplid, B.; Nilsson, A.; Roennbaeck, C.; Eriksson, K.-H. Acta Radiol., Suppl.; No. 310, 181-99(1971).

Groups of mice were exposed to repeated doses of 80 R and 160 R at various time intervals with a view to studying the protective effect of cysteamine against late effects from sublethal doses of irradiation. The accumulated doses were selected to fall definitely in the range between sublethal and supralethal doses. Half the number of animals in each group were given cysteamine before each irradiation. The histopathological diagnoses at death were investigated among those surviving the acute effects, i.e., 30 days after last irradiation. It was concluded that cysteamine had a protective effect only against radiation induced unclassified leukemias. The effect on other specific late effects was equivocal. (auth)

53476 GASTRULATION IN MOUSE EMBRYOS IN COURSE OF RADIATION INJURY. Rudnicki, Tadeusz; Kochmanska, Anna (Zaklad Radiobiologii Instytutu Nauk Fizjologicznych, Poznan, Poland). Nukleonika; 17: No. 3-4, 249-58(1972). (In Polish).

Early mouse embryos were irradiated with 200 rads of x rays just as gastrulation was started. At 2, 12, 24, 36, and 48 hr after irradiation, the mitotic activity in cells of germ layers and cell death following radiation injury, as well as the influence of these alterations at the cellular level on the process of gastrulation and neural tube formation was studied. It was found that both cell death and depression of mitotic activity occurred, but embryos were able to compensate these injuries in a short time. The only consequence of these alterations, morphologically evident, was the retardation of embryo development for about 12 hr as compared with normals. It follows from these studies that morphological criteria in estimation of mechanisms of fundamental radiobiological effect in early mouse embryo (i.e., its death) are not useful. (auth)

53477 INTERACTION OF EMBRYONIC CHICKEN SPLEEN CELLS AND ADULT ALLOGENEIC LEUCOCYTES. Kilby, Virginia A. A.; Lafferty, K. J.; Ryan, Madeleine A. (Australian National Univ., Canberra). Aust. J. Exp. Biol. Med. Sci.; 50: No. 3, 309-21(Jun 1972).

Leucocytes from inbred AA chickens produced pocks when inoculated onto the chorioallantoic membrane of non-inbred embryos (direct pock formation), but produced very few or no pocks on the chorioallantoic membrane of syngeneic embryos. Pock formation was observed when AA leucocytes were mixed with non-inbred embryonic spleen cells before being assayed on the chorioallantoic membrane of recipient embryos that were unresponsive to either cell population alone (indirect pock formation). Indirect pock formation was found to be more γ radioresistant than direct pock formation and doses of Mitomycin-C that inhibited direct pock formation by AA leucocytes did not inhibit the capacity of these cells to induce indirect pocks. Indirect pock formation was inhibited when non-inbred embryonic spleen cells were treated with Mitomycin-C prior to mixing with AA leucocytes. It is suggested that indirect pock formation does not result from the stimulation of adult leucocytes by antigen presented on the surface of allogeneic embryonic cells. Rather, this response is a manifestation of the direct stimulation of embryonic spleen cells by adult allogeneic leucocytes. (auth)

53478 DIURNAL RHYTHM OF NEUROSECRETORY ACTIVITY IN NORMAL AND X-RAY IRRADIATED MICE. Lach, H.; Srebro, Z. (Teacher Training Coll., Krakow). Acta Biol. Acad. Sci. Hung.; 23: No. 1, 1-9(1972).

The nuclear diameter of neurosecretory cells and the amount of neurosecretory material (NSM) were measured in the hypothalamo-neurohypophysial neurosecretory system of adult male albino mice at different hours of the day. The amount of NSM was estimated cytophotometrically. It was highest at 6 p.m. both in the neurosecretory centres and in the posterior lobe. The lowest values occurred at noon in the hypothalamic nuclei and at midnight in the posterior lobe. X irradiation considerably changed this rhythm: a decrease was observed in the supraoptic and paraventricular nuclei 13 hrs postexposure. The posterior lobe, on the contrary, showed at that time increased amounts of NSM as compared with the control. The difference between the irradiated and control animals was statistically significant as well as the maximal intragroup differences (maxima vs. minima). Neurosecretory cell nuclear diameter showed a distinct diurnal variation. Significant differences were observed between normal and irradiated animals. (auth)

53479 ROLE OF THE THYMUS IN THE POSTRADIATIONAL RESTORATION OF THE BONE MARROW IN RATS. Fedotova, M. I.; Belousova, O. I. Byull, Eksp. Biol. Med.; 73: No. 4, 101-5(Apr 1972). (In Russian).

Experiments were carried out on 470 Wistar rats subjected to the operation of true or fake thymectomy. A study was made (by quantitative methods) of bone marrow restoration following irradiation with γ rays of ^{60}Co in doses of 400 and 700 R. Restoration of bone marrow cells proved to be delayed (in comparison with control) in thymectomized rats. The number of lymphoid cells was reduced at the period from the 10th to the 15th day, and of myeloid cells—at later periods. A conclusion was drawn that migration of thymocytes into the bone marrow occurred during the postradiation period. An association of the mentioned phenomenon with the subsequent restoration of myelopoiesis is supposed. (auth)

53480 ANIMAL EXPERIMENTAL EXAMINATIONS ON THE EFFECT OF IONIZING RADIATION ON THE MAXILLARY BONE WITH METALLIC BRIDGES. Beetke, E.; Bienengraeber, V.; Hafke, P.; Kittner, K.-H. (Univ., Rostock, Ger.). Radiobiol.-Radiother.; 13: No. 3, 367-74(1972). (In German).

For the further elucidation of the influence of metallic bridges on the surrounding tissue in γ irradiation, experimental examinations were performed with five dogs. The radiation reactions in the environment of teeth surrounded by lead are compared with reactions with undressed teeth and with those teeth having the lead ring covered by a plastic cap. The results of these examinations are given. (auth)

53481 OBSERVATIONS ON THE COMBINED RADIOPROTECTIVE EFFECT OF PANTOTHENIC ACID AND AMINOETHYLISOTHIURONIUM. Szegszardy, T.; Gazdagh, I.; Szorady, I. (Medizinische Univ., Szeged). Radiobiol.-Radiother.; 13: No. 3, 375-8 (1972). (In German).

Together with pantothenic acid, the radioprotective effect of AET in mice in the case of a whole-body irradiation of 800 R can be greatly increased. This is manifested by the survival percentage of the animals, in the prolonged survival, and in a decrease of the postirradiation loss of weight. (auth)

53482 VARIATIONS OF THE ^{75}Se-SELENOMETHIONINE ERYTHROCYTIC INCORPORATION INDUCED IN THE RAT BY PAN-IRRADIATION. Martinenghi, C.; Bergonzi, M.; Limido, G. (Univ., Milan). Med. Nucl.-Radiobiol. Lat.; 12: No. 3-4, 153-71(1969). (In Italian).

The study of the variations of the ^{75}Se-selenomethionine erythrocytic incorporation induced in the rat following γ pan-irradiation with different doses showed a linear correlation between the logarithmic exposition and the maximum value of the erythrocytic radioactivity concentration, expressed as a ratio with the maximum value observed in the nonirradiated control animals. The analysis of the curve showing the variations of the radioisotope erythrocytic incorporation as a function of time shows that such a curve may be analytically expressed, with good approximation, by a monoexponential function. (auth)

53483 STUDY AS A FUNCTION OF TIME AND DOSE OF THE NUMERICAL VARIATIONS OF THE LEUCOCYTES CIRCU-

LATING IN A TOTALLY IRRADIATED RAT. Martinenghi, C.; Bergonzi, M.; Fidanza, M. A.; (and others) (Univ., Milan). Med. Nucl.-Radiobiol. Lat.; 12: No. 3-4, 245-66(1969). (In Italian).

One hundred and sixty two Norwegian white rats were whole-body γ-irradiated and divided into nine groups on the basis of exposure times. The time variation of the total leucocythemia, lymphocythemia, and neutrophilous granulocythemia was studied numerically, extending the study to 32 days after irradiation for the surviving animals. A correlation was observed between exposure and biological effects, by studying the behavior of the circulating leucocytes and especially by examining separately the granulocytic and lymphocytic curves. In particular, a quantitative measure was given to the correlation between lymphocytic damage and exposure, at least within the experimental dosage range. (auth)

53484 RELATIVE BIOLOGICAL EFFECTIVENESS OF ^{252}Cf ON ACUTE MAMMALIAN LETHALITY. Dean, Frederick K.; Bushong, Stewart C.; Prasad, Naresh; Briney, Sharon (Baylor Univ., Houston, Tex.). Radiology; 104: No. 3, 699-703(Sep 1972).

The relative biological effectiveness (RBE) of ^{252}Cf was compared with radium on the basis of lethality over a 30-day period. Mice were irradiated with ^{252}Cf, radium, and ^{60}Co. Probit analysis of the number of deaths showed an $LD_{50/30}$ of 537 rads for ^{252}Cf, 1,286 rads for 240 mg radium, 1,609 rads for 120 mg radium, and 663 rads following high-dose ^{60}Co. The RBE estimate for ^{252}Cf compared to radium over a comparable time interval is 3.01. These findings are consistent with other recently reported RBE values. The ^{60}Co values were not compared due to differences in dose distribution and dose-rate. (auth)

53485 INCIDENCE OF DELAYED MORTALITY (SECONDARY DISEASE) IN ALLOGENEIC RADIATION CHIMERAS RECEIVING BONE MARROW FROM AGED MICE. Chen, Michael G.; Price, Gerald B.; Makinodan, T. (Oak Ridge National Lab., Tenn.). Exp. Hematol.; 22: No. 1, 68-9(Mar 1972).

The effect of aging on a cell-mediated immune function; namely, the ability of bone marrow from aged donor mice to cause secondary disease and death in young, lethally irradiated, allogeneic recipient mice was studied. The influence of the thymus on the potential effector cells in the bone marrow was also examined. Studies were made using, (C57BL/Cum ($H\text{-}2^b$) × C3H/Anf Cum ($H\text{-}2^k$) mice (hereafter $BC3F_1$) of both sexes as bone marrow donors. Old mice were 25 months or more in age; young mice were 3 to 6 months old. Recipient mice were (BALB/c MI($H\text{-}2^d$) × DBA/2 MI ($H\text{-}2^d$) hybrids (hereafter $CD2F_1$), 2 to 5 months old, of both sexes. These recipients were given 850 R whole-body x irradiation and injected with $5-7.5 \times 10^6$ ($BC3F_1$) bone marrow cells within 3 hr of irradiation. In one series of experiments, $BC3F_1$ donors received 400 R whole-body radiation 22 days before sacrifice and collection of bone marrow for transplantation. Thymectomies were performed on groups of old and young $BC3F_1$ donors and $CD2F_1$ recipients at two months of age. Daily tabulation of deaths in each group of recipient mice was made, excluding the few animals dying during the first two weeks. Postmortem examination was performed on a random sample of mice dying with each group, and survivors were tested for erythrocyte chimerism. These results are compatible with existence of a large, long-lived stable population of cells, reactive in initiating delayed mortality, which does not diminish appreciably with senescence. (C.H.)

53486 SEROTONIN UPTAKE BY PLATELETS IN ACUTE RADIATION SICKNESS. Dorofeev, V. M.; Nestaiko, G. V. (Inst. of Medical Radiology, Obninsk, USSR). Byull. Eksp. Biol. Med.; 73: No. 5, 58-60(May 1972). (In Russian).

It was shown on 35 Chinchilla rabbits irradiated at a dose of 600 R (gamma-rays of ^{60}Co, dose rate = 140 R/min), that the capacity of blood platelets for serotonin uptake proved to diminish at the height of the acute radiation sickness. The authors consider that disturbance of this platelet function can serve as one of the causes of serotoninopenia in the blood in acute radiation sickness. (auth)

53487 EFFECTS OF GAMMA RADIATION ON THE SHARK BRAIN. Olsson, Yngve; Carsten, Arland L.; Klatzo, Igor (National Inst. of Health, Bethesda, Md.). Acta Neuropathol.; 21: No. 1, 1-10(1972).

A comparison was made between the effects of gamma radiation on the elasmobranch and the mammalian brain. Thirty-seven nurse sharks (Ginglymostoma cirratum) received a single exposure, in a range of 1,000 to 30,000 rads, to the brain. The animals remained seemingly unaffected in their behavior and at their sacrifice, between one day and 28 months after irradiation, no histological changes could be detected with the exception of one shark (exposed to 30,000 and sacrificed after 12 months) which showed two small necrotic lesions in the tegmentum. No detectable difference in amount and distribution of glycogen in the brain could be demonstrated between irradiated and non-irradiated sharks. Also, the irradiated sharks showed no changes of the blood-brain barrier to protein tracer. Rats irradiated with 25,000 to 30,000 rads to the brain from the same source died shortly after exposure or showed extensive necrotic lesions in the brain. There was also an intense accumulation of glycogen mostly in the astrocytes and a widespread disturbance of the blood-brain barrier to Evans Blue-albumin tracer. (auth)

53488 EFFECT OF SMALL X-RAY DOSES ON THE MOTOR ACTIVITY OF RATS IRRADIATED DURING THEIR EMBRYONIC DEVELOPMENT. Baev, Il.; Paskalev, Z.; Benova, D.; Banceva, E. Rentgenol. Radiol.; 10: No. 3, 194-9(1971). (In Russian).

The motor activity of 2 month-old rats exposed on the 14th day of their embryonic development to 5, 10, 15 or 25 R of x-rays was studied. The quantitative and qualitative characteristics of the movements induced by a sound stimulant served as an index of the motor activity. In the group of animals exposed to 5 and 10 R the motor reactions were reduced, whereas in animals exposed to 15 and 25 R the mean value of these same reactions was significantly increased as compared with control animals. (Abstr. Bulg. Sci. Med. Lit.)

53489 POSTIRRADIATION SYNTHESIS AND DEGRADATION OF DNA IN VARIOUS TISSUES OF RATS. Kang, Man Sik. Tongmul Hakhoe Ji; 14: No. 4, 199-204(1971).

The effect of 400 R total-body x-irradiation on the rate of deoxycytidine-2-^{14}C (CdR-2-^{14}C) incorporation into DNA and on the degradation of DNA has been studied in the liver, spleen and thymus of the rat. The postirradiation period can be divided into a radiation reaction period followed by a regeneration period. During the period of radiation reaction, which consists of days 1–2, markedly decreased CdR-2-^{14}C incorporation into DNA of each organ is observed. The rate of incorporation of labeled precursor in the thymus shows the most profound decrease. The change in the amount of DNA as percent of normal exhibits a similar pattern in all organs, but the rate of decrease is larger in the spleen and thymus compared to that in the liver. The period of regeneration as judged by the incorporation experiment appears on day 4 to 5. The second phase is highlighted by a markedly increased rate of CdR-2-^{14}C incorporation and by a slow and continued increase in the amount of DNA in all organs. The regeneration occurs faster in the liver and spleen than in the thymus which is the most radiosensitive of all. The findings of the present experiments are strongly suggestive of the fact that the radiation-induced loss of spleen and thymus DNA as well as the radiation induced inhibition in the CdR incorporation into DNA of the thymus are the important factors in the elevated levels of CdR in the urine and plasma. (Korean Sci. Abstr.)

53490 EFFECT OF CORTISONE ON SERUM PROTEIN OF GAMMA-IRRADIATED MICE. Cho, You Joung; Choi, Kook Hun; Ham, Sang Yul. Tongmul Hakhoe Ji; 14: No. 3, 119-24(1971). (In Korean).

Male mice of strain SM were given 128 rads of single whole-body gamma irradiation of ^{60}Co, 14 to 16 minutes following a subcutaneous injection of physiological saline or cortisone acetate (1 mg/day, for 4 days preirradiation). The serum protein patterns and the level of the total serum proteins were determined at various time intervals after exposure. Total body gamma-irradiation caused a rise in the level of the total serum protein at 1 day and in the level of the serum albumin-globulin ratio at 5 days in both cortisone acetate-treated and control groups. Cortisone acetate delayed the total serum protein rise at 5, 10, and 20 days after exposure. Cortisone acetate delayed the A/G ratio rise at 1, 5, and 10 days after exposure. It may be inferred that cortisone greatly reduces the sensitivity of mice to gamma-irradiation on the blood protein, provided that cortisone is given before the exposure. (Korean Sci. Abstr.)

53491 ACTIVITY CHANGES IN LOCALLY IRRADIATED RAT LIVER L-ARGININE AMIDINOHYDROLASE (EC 3, 5, 3, 1) FOLLOWING IRRADIATION AT DOSES OF 2000 R, 4000 R, AND 8000 R. Bathori, Edit. Kiserl. Orvostud.; 24: No. 3, 289-92 (Jun 1972).

Studies with male Wistar rats are described. The results are analyzed statistically, using the Student-t test. Observations were carried out for 21 days following irradiation. Significant activity changes were found only following irradiation with large total doses. In the case of lower doses (2000 to 4000 R), there was only a temporary (few days) activity increase after irradiation. The activity of the L-arginine amidinohydrolase does not indicate the damages to the liver that may have been caused by irradiation. (JPRS)

53492 ORIGIN OF ALVEOLAR MACROPHAGES IN MOUSE RADIATION CHIMERAS. Godleski, John J.; Brain, Joseph D.

(Harvard Univ., Boston). J. Exp. Med.; 136: No. 3, 630-43 (1 Sep 1972).

This investigation attempted to determine whether the primary source of alveolar macrophages is pulmonary or hematopoietic. An antigenic marker was used to identify cells of hematopoietic origin. Mouse chimeras were produced by irradiating $C57B6/AF_1$ mice (900 R) and then injecting them intravenously with $B10D2/AF_1$ bone marrow. The donor animal has an antigenic specificity on the H-2 locus, not shared by the recipient. Alveolar macrophages were obtained by repeated lung washings with physiologic saline at 37°C. Cytotoxic tests were done on bone marrow and alveolar macrophages using anti-31 mouse antibody, absorbed rabbit serum as complement, and trypan blue exclusion as a test for viability. Animals were studied at 7, 14, 21, 28, and 35–50 days and 4, 5, 8, and 11 months after irradiation and bone marrow replacement. By 21 days after irradiation, 90% of the animals had greater than 80% replacement of marrow with donor tissue; and white blood cell and alveolar macrophage counts approached normal. At this time and at later intervals the per cent of donor cells in the lung free cell population was not significantly different from the per cent of donor cells in the bone marrow. Similarly, after aerosol particulate exposure, the percentage of marrow cells and alveolar macrophages of donor origin were not significantly different. This immunologic approach suggests that alveolar macrophages in radiation chimeras are entirely of hematopoietic origin. (auth)

53493 RESPIRATION AND STRUCTURAL CHANGES OF MITOCHONDRIA OF INTESTINAL EPITHELIAL CELLS IN THE COURSE OF AMINO ACID ABSORPTION IN IRRADIATED ANIMALS. Strelina, A. V.; Batyuto, T. D.; Manina, A. A. (Central Research Roentgeno-Radiological Inst. of Experimental Medicine, Leningrad). Byull. Eksp. Biol. Med.; 73: No. 5, 60-3(May 1972). (In Russian).

Stimulation of respiration and ultrastructural transformations of mitochondria in the epithelial cells of the jejunum in absorption of amino acids (a mixture of alanine and glycine) were shown in experiments on intact rats. Amino acid absorption was accompanied by diminished oxygen utilization and a reduction of ultrastructure reaction within 30 min after whole-body x-ray irradiation in a dose of 600 rad. The results obtained are discussed from the aspect of the effect of radiation on the systems of reproduction of energy and energy-dependent functions. (auth)

53494 EFFECT OF X-RAY IRRADIATION ON REGENERATION OF THE THYROID GLAND IN RATS WITHOUT TUMORS AND AFTER INOCULATION OF SARCOMA-45. Prizhivoit, I. F.; Matyushkova, R. M. (Research Inst. of Oncology and Radiology, Frunze, USSR). Byull. Eksp. Biol. Med.; 73: No. 5, 96-8(May 1972). (In Russian).

Three fourths of the thyroid gland was resected in 240 rats, and its condition was studied postoperatively. The first group of rats served as control; the second group was totally irradiated in a dose of 360 R 24 hrs before the operation; sarcoma-45 was inoculated eight days before the operation to rats of the third group; in difference from the third group, tumor-bearers of the fourth group were subjected to irradiation 24 hrs before the operation. Comparison of the results in these four groups has shown that irradiation of animals without any tumor inhibited the regenerative growth of thyroid epithelium 3.8 times; the presence of a tumor, 7 times; and irradiation of tumor-bearers, only 1.6 times. Consequently, irradiation of tumor-bearers eliminated the inhibition of regenerative processes in the thyroid gland caused by the tumor, and the presence of the tumor reduced the effect of irradiation. (auth)

53495 COURSE OF THE POST-IRRADIATION SYNDROME AFTER IRRADIATION WITH LETHAL DOSES IN NEWBORN CONVENTIONAL, GERM-FREE AND ESCHERICHIA COLI-MONOASSOCIATED PIGLETS. Miler, I.; Mandel, L.; Moravek, F.; Kruml, J.; Klepalova, J. (Inst. of Microbiology, Prague). Folia Microbiol. (Prague); 17: No. 4, 291-9(1972).

The influence of whole-body irradiation with lethal doses of ionizing radiation (^{60}Co) was studied in conventional, germ-free, and Escherichia coli-monoassociated newborn piglets. The dose 1,200 R produced an acute intestinal death (i.e. within 3 to 4 days) in conventional animals, whereas survival was three times as long in their germ-free counterparts. Artificial colonization of the intestinal tract of germ-free piglets with non-pathogenic strain of Escherichia coli, prior to irradiation with the same dose, produced the conventionalization of these animals and reduction in the survival time almost to the level of conventional animals. In conventional animals, profound focal regressive changes of the epithelium accompanying the denudation of intestinal villi were found already on the 2nd to 3rd day after irradiation with 1,200 R. On the other hand, the intestinal epithelium of germ-free piglets, irradiated with 1,200 R, was found to be intact on the 7th to 9th day of post-irradiation, and the first signs of damage started to occur around the 9th to 10th days. The morphological characteristics of the intestinal mucous membrane of Escherichia coli-monoassociated piglets were comparable to those of conventional, irradiated piglets. The role of the presence of the microbial factor for the turnover and radiosensitivity-resistance of enterocytes, and for the survival-death rate of animals irradiated with doses producing the post-irradiation gastrointestinal syndrome, is discussed. (auth)

53496 LEUKEMOGENIC EFFECT OF RADIOSTRONTIUM (^{90}Sr) IN MICE, A COMPARATIVE STUDY OF LEUKEMOGENICITY OF ^{90}Sr AND X-RAYS. 2. TRANSMISSIBILITY OF THE INDUCED LEUKEMIAS, ALKALINE PHOSPHATASE ACTIVITY AND CYTOGENETIC CHANGES OF LEUKEMIC CELLS. Ito, Takaaki (Hiroshima Univ.). Nippon Ketsueki Gakkai Zasshi; 33: No. 4, 432-48(Aug 1971). (In Japanese).

Studies were made on the transmissibility of leukemias, the alkaline phosphatase activity, and chromosome changes of the leukemic cells, which were induced by intraperitoneal administration of ^{90}Sr or fractionated whole-body x irradiation. Cell-free extracts prepared from leukemias induced either by ^{90}Sr or x rays were inoculated into newborn ICR/JCL, ddN/JCL, or RFM/U strains of mice. Of eight cases of ^{90}Sr-induced leukemia, five were transmitted in recipient mice with a latency period of 73 to 547 days, though the leukemogenic potency of extracts was rather low (9.1 to 33.3%). Of four cases of the x-ray-induced leukemia, three were transmitted in ICR/JCL and ddN/JCL mice with a latency period of 240 to 465 days; the leukemogenic potency of these extracts was also low (9.1 to 23.1%). Serial cell-free transmissions were also achieved in two cases of leukemia originally induced by ^{90}Sr. These results strongly suggest that virus may participate in induction of leukemia by ^{90}Sr as it does in leukemia induction by x rays. Alkaline phosphatase (AP) activity of leukemic cells was histochemically determined. AP activity in ^{90}Sr-induced leukemias elevated remarkably, whereas it varied from negative to moderately positive in x-ray-induced cases. Although a few cases showed high AP activity, most cases showed negative or low activity in cell-free passaged leukemias which were originally induced by ^{90}Sr. In the majority of leukemias induced by ^{90}Sr or x-rays, abnormalities in chromosome number such as aneuploidy, polyploidy and pseudo-polyploidy were frequently observed. In 2 cases, one induced by ^{90}Sr and the other by x-rays, respectively, structural abnormalities such as metacentric, minute or giant chromosome were observed in majority of cells, suggesting the proliferation of leukemic stem cell with the marker chromosome. The chromosome abnormalities were relatively infrequent in cell-free passaged leukemias, which were originally induced by ^{90}Sr. (Japan)

Invertebrates

Refer also to abstract 53365.

53497 (COO-1748-12) TOTAL RADIATION-INDUCED GENETIC DAMAGE IN ENTIRE GENOMES OF DROSOPHILA MELANOGASTER. Progress Report, November 1, 1971–October 31, 1972. Valencia, Ruby M. Allen (Wisconsin Univ., Madison). [nd]. Contract AT(11-1)-1748. 30p. Dep. NTIS.

Mature spermatozoa of Drosophila melanogaster were treated with acute doses of 4000 R or 2000 R, x rays. The frequency of damaged genomes among those recovered and studied was 63.2% for 4000 R and 54.8% for 2000 R, but the rate of damage induction among treated sperm was 89.3% for 4000 R and 73% for 2000 R. The rate of heritable damage induction among treated sperm was 10.7% for 4000 R and 27.6% for 2000 R. In addition, the damage transmitted was qualitatively different at the two doses. (C.H.)

53498 (PRNC-156) FASCIOLA HEPATICA PROGRAM IN PUERTO RICO. Progress Summary Report, December 1971. Chiriboga, Jorge; de Leon, Delfin; Ritchie, Lawrence S. (Puerto Rico Nuclear Center, Mayaguez). 1972. Contract AT(40-1)-1833. 61p. (In English and Spanish). Dep. NTIS.

Progress is reported on the following research projects: life cycle studies on Fasciola hepatica using the snails, Lymnaea cubensis and L. columella, as vectors and rats and mice as final hosts; studies on vaccination of cattle using irradiated metacercariae; liverfluke infestation of cattle in relation to economic losses in the livestock industry; studies on growth, reproduction, and life span of Lymnaea cubensis; methods for mass production of F. hepatica miracidia; immunogenic effects on rats of triple vaccination with 2500 R gamma-irradiated F. hepatica metacercariae; immunogenic responses of cattle to oral vaccination with gamma-irradiated metacercariae; cryptobiosis of snail vectors of F. hepatica in the tropics and its epidemiological importance; and comparative studies on susceptibility of L. cubensis and L. columella to F. hepatica infection. (H.L.W.)

53499 RADIOSENSITIVITY OF THE OVOCYTES IN SITOTROGA CEREALELLA OLIV. Dryanovska, O. A.; Glavanakova, S. I. Compt. Rend. Acad. Bulg. Sci.; 25: No. 2, 253-4(1972).

The γ-radiosensitivity of the late prophase and the early metaphase of meiosis in the oocytes of the grain moth (Sitotroga cerealella) was studied. Irradiated females were mated with normal males and the number of eggs hatching during the first 24 hrs, corresponding to irradiation at early metaphase, and during the second 24 hrs, corresponding to irradiation at late prophase, was determined. Results indicated that oocytes in the early metaphase of meiosis were more sensitive to γ irradiation than those in late prophase. (E.R.B.)

53500 ACTION OF SMALL DOSE OF RADIATIONS UPON THE MANIFESTATION OF BAR GENE IN DROSOPHILA MELANOGASTER MEIG. Precup, O.; Pora, E. A. Stud. Cercet. Biol., Ser. Zool.; 23: No. 5, 465-77(1971). (In Rumanian).

Homozygote Bar mutants of Drosophila melanogaster were used to investigate the effect of a 900 mR dose of radiation upon the manifestation of Bar gene. The irradiation was made in the gametic or pregametic cell stage and the larval stage. It was noticed the above mentioned dose of radiation acted in a metabolic-stimulatory way, demonstrated by the increase of the mean number of omatidia by Bar mutants of both sexes. (Rom. Sci. Abstr.)

53501 CHROMOSOMAL INTERCHANGE IN MATURE OOCYTES OF DROSOPHILA. Parker, D. R.; Busby, Nancy (Univ. of California, Riverside). Mutat. Res.; 16: No. 1, 49-58(Sep 1972).

Detachments of a reversed acrocentric compound-X chromosome (C(1)RA) resulting from interchange with a doubly-marked Y chromosome (y^+Yy^+) were induced by irradiating mature, stage-14 oocytes in 5-day-old, adult virgin females of Drosophila melanogaster. The period of egg laying after irradiation was limited to 12 hr to prevent inclusion in the sample of eggs that were irradiated in immature stages. It was confirmed that some rearrangements must be completed prior to the completion of division I, since chromosomes that regularly assort apart at division I—C(1)RA and y^+Yy^+—have been able to interchange parts to permit the recovery of half-translocations. Further evidence is afforded by the higher recovery of proximal (capped) than of distal (captured) X's, from which can be inferred nonrandom segregation of heteromorphic dyads. The absence of fractionation effects in mature oocytes was accounted for in previous publications by postulating delayed repair, but the delay cannot extend beyond the initiation of chromosome movement in division I of meiosis. Our data, however, do not exclude the possibility that some interchanges might be completed postmeiotically, but neither do they suggest it. It is argued that the kinds of data that were derived from mature Drosophila oocytes are not yet adequate to form a basis for choosing between breakage-first and exchange models of interchange. The significance of these findings in relation to the kinds of aberrations that can be recovered from irradiated mature oocytes is briefly discussed. (auth)

53502 EFFECTS OF TREATING DROSOPHILA FEMALES WITH ACTINOMYCIN-D ON THE YIELDS OF DOMINANT LETHALS, TRANSLOCATIONS, AND RECESSIVE LETHALS RECOVERED FROM X-IRRADIATED SPERMATOZOA. Proust, Jacqueline P.; Sankaranarayanan, K.; Sobels, F. H. (Univ. of Leiden). Mutat. Res.; 16: No. 1, 65-76(Sep 1972).

Drosophila females were injected with actinomycin-D. After a day they were mated (for 24 hr only) to males that were exposed to 2000 or 2500 R x irradiation, so that only mature spermatozoa were sampled. The radiation-induced frequencies of dominant lethals, II-III translocations, and recessive sex-linked lethals in the paternal genome were determined. When compared to the appropriate controls, it is found that such treatment of the females with actinomycin leads to an increase of the frequency of dominant lethals and to a decrease of those of translocations and recessive lethals. Characteristic is the delayed expression of the actinomycin effect, in that the modification of translocation and recessive lethal frequencies is most pronounced in oocyte stages utilized 4 to 6 days after injection. The present findings are interpreted to mean that actinomycin acts by partially inhibiting the restitution of chromosome breaks, thereby increasing the frequency of dominant lethals, and decreasing that of translocations and recessive lethals. This implies that maternal repair processes acting at the stage of pronucleus formation are required for the repair (restitution) or misrepair (reunion giving rise to translocations) of chromosome breaks induced in mature spermatozoa. (auth)

53503 EXPERIMENTAL VERIFICATION OF EFFECTIVENESS OF RADIATION VACCINE AGAINST CATTLE DICTYOCAULOSIS. Pokorna, J. (Bioveta, Ivanovice na Hane, Czech.). Veterinarstvi; 22: No. 1, 16-19(1972). (In Czech).

The results are presented of experiments carried out in 1971 with active immunization of cattle against dictyocaulosis by irradiated vaccine. The vaccine was prepared from the larval suspension of stage III Dictyocaulus viviparus by x-irradiation. The double administration of the irradiated vaccine to the experimental animals resulted in a highly significant protection of the immunized animals against subsequent massive invasion by non-irradiated larvae. The similar dose of larvae administered to the control group resulted in grave dictyocaulosis. The evaluation of the effect of the vaccine was based on clinical investigations of the health conditions of the animals, the excretion of larvae in the faeces, and on the pathological and anatomical findings yielded by autopsy. The results pertaining to the experimental and control animals showed statistically significant differences. (INIS)

53504 EFFECT OF γ RADIATION ON THE RESISTANCE AND LONGEVITY OF TWO ONISCOIDEAS SPECIES: PORCELLIO DILATATUS AND CHAETOPHILOSCIA SICULA AND THEIR MUTANTS. Bonnet, Louis; Dalens, Henri (Univ., Toulouse). Compt. Rend., Ser. D; 274: No. 20, 2794-7(15 May 1972). (In French).

Marked differences occur between the radiation resistance of Porcellio dilatatus and Chaetophiloscia sicula, the species being represented by their wild phenotypes and certain mutant phenotypes. Great similarity is however observed between phenotypes belonging to the same species. (France)

Radionuclide Effects (Internal Source)

Refer also to abstracts 53021, 53024, and 53396.

53505 CELLULAR LESIONS INDUCED BY EXTERNAL AND INTERNAL RADIATION SOURCES. Goutier, R. (CEN, Mol, Belgium). J. Belge Radiol.; 55: No. 2, 253-62(1972). (In French).

Chain breaks in DNA seem to be at the origin of the short term lethal effect of ionizing radiation from external source, as well as of the lethal effect of an incorporated radionuclide. The RBE of β-rays of incorporated ^3H for lethal effect is close to one, since, for that particular effect, x rays and ^3H-β-rays both act by ionization, provided the dose of β-rays calculated be the dose received by DNA. Therefore, the maximal efficiency of a radionuclide is provided by carrier molecules which, such as thymidine, are specifically incorporated into DNA; any incorporation in another site of the cell results in a decreased killing efficiency of ^3H. In the mutagenic effect of ^3H and in the lethal as well as mutagenic effects of ^{14}C and ^{32}P, transmutation seems to play an important role not only by producing DNA chain breaks but also by producing changes in base pairing (point mutation). Lastly, DNA repair processes, well known after uv or x irradiation, also seem to occur during the action of an incorporated radionuclide. (auth)

Man

Refer also to abstracts 53419, 53511, and 53542.

53506 (ORNL-tr-2629) AGE-DEPENDENT INGESTION DOSE FACTORS g_C AND $g_{C'}$ OF ^{131}I. Bayer, A. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). Translated for Oak Ridge National Lab., Tenn., from report KFK-1582. 38p. Dep. NTIS.

An age-dependent curve for fallout ^{131}I ingestion by children was obtained, based on the iodine concentration in milk. The extended ingestion dose, based on the iodine concentration in air and the milk-air-transport factor was determined. The extended ingestion dose was compared with the inhalation dose. A proposed maximum thyroid dose of 90 mrem/yr for children, based on the maximum iodine concentration in air of $3.6 \cdot 10^{-14}$ C/m^3, is proposed. (C.H.)

53507 COMBINED FRACTIONATED ISOTOPIC AND EXTERNAL IRRADIATION OF THE LIVER IN HODGKIN'S DISEASE. A STUDY OF 21 PATIENTS. Kraut, Joseph W.; Kaplan, Henry S.; Bagshaw, Malcolm A. (Santa Clara Valley Medical Center, San Jose, Calif.). Cancer; 30: No. 1, 39-46(Jul 1972).

Of 21 Hodgkin's disease patients with laparotomy-documented splenic and/or hepatic involvement (Stages III_S and IV_H) treated with total lymphoid and combined external and internal (^{198}Au) whole liver irradiation, nine patients remain disease-free for 17 to 34 months. All but two of the relapses occurred in patients previously treated to local fields only. One death is directly attributable to the isotope. Another death at 34 months was due to intercurrent disease. About half of the combined whole liver dose of 2,500 rads is delivered by external megavoltage x-ray therapy and half by radioactive colloidal gold (^{198}Au). The usual isotopic dose is 25 to 30 mCi administered intravenously at a maximum rate of 10 mCi every 2 weeks. Tumoricidal doses can thus be delivered

to the critical periportal areas within the liver, whereas dose to the central vein region of the lobule remains within the normal liver tissue tolerance level, thus avoiding the immediate reaction of radiation hepatitis and the remote development of cirrhosis. Thrombocytopenia, the most serious complication, may be prevented or lessened by adjusting the fractionated and total dose of the isotope. (auth)

53508 RELATIONS BETWEEN THE INHALED POTENTIAL α-ENERGY OF ^{222}Rn- AND ^{220}Rn-DAUGHTERS AND THE ABSORBED α-ENERGY IN THE BRONCHIAL AND PULMONARY REGION. Jacobi, W. (Hahn-Meitner-Institut fuer Kernforschung GmbH, Berlin). Health Phys.; 23: No. 1, 3-11(Jul 1972).

On the basis of the new ICRP-lung model the ratio of the absorbed α-energy or integral α-dose in the bronchial and pulmonary region to the inhaled potential α-energy was estimated as functions of the aerosol concentration, the ventilation rate, and the wall-deposition rate in the working area. With increasing aerosol concentration and decreasing ventilation rate this ratio decreases in the bronchial region but increases in the pulmonary region. The possible variation of bronchial and pulmonary dose per WLM inhaled is also discussed with respect to the maximum permissible annual intake of Rn- and Tn-daughters. (auth)

53509 DOSIMETRY IN THE USE OF COLLOIDAL ISOTOPES. Fleay, R. F. (Royal Perth Hospital, Australia). Australas. Radiol.; 15: No. 4, 388-90(Nov 1971).

Measurements have shown detectable levels of radioactivity in the urine and high levels of radioactivity in the pleural fluid of patients many days after injection of phosphorus-32 and gold-198 colloids used for treatment of malignant pleural effusion. These findings led to a review of the procedure at present in use in the hospital and an estimation of the radiation doses. (auth)

53510 COMPARISON OF TECHNIQUES FOR CALCULATING DOSES TO THE WHOLE BODY AND TO THE LUNGS FROM RADIOACTIVE NOBLE GASES. Russell, John L.; Galpin, Floyd L. (Environmental Protection Agency, Rockville, Md.). pp 286-308 of Radiation Protection Standards: Quo Vadis. Vol. II. Howell, Wallace P. (ed.). Richland, Wash.; Health Physics Society (1972).

From 6th annual topical symposium on radiation protection standards: quo vadis; Richland, Wash. (2 Nov 1971).

An issue that is frequently discussed in connection with dose projections of the radioactive noble gases krypton and xenon is the degree of conservatism built into the recommended maximum permissible concentrations through simplifying assumptions. The ICRP recommendation requires summation of the effective energy per disintegration and no differentiation is made relative to β and γ contributions. Thus, the energies of the β particles are included as contributors to the whole body dose, regardless of the fact that most of the energy is delivered to the skin. The methodology recently developed by the Medical Internal Radiation Dose Committee is used to estimate whole body and lung doses for the γ component of the radioactive gases constituting the plume of a boiling water nuclear power reactor (BWR) for three exposure pathways: gas dissolved in body tissues; immersion in an infinite cloud of gas; and gas in the lung. Estimated doses for β particles are calculated for the same pathways. The summations of the γ and β whole body doses in a MPCa cloud range between 3% and 60% of 500 mrad per year for the noble gases with established decay schemes. The contribution of gases in the lung and dissolved in body tissues to the whole body dose is a small fraction of this. The projected dose for a BWR plume at a weighted MPC with 30 minutes decay is 322 mrad per year, or approximately 65% of the 500 mrad per year recommended Radiation Protection Guide. (auth)

Animals

Refer also to abstracts 53459, 53472, and 53496.

53511 (TID-26142) RISKS AND EMERGENCY RADIATION DOSES FROM PLUTONIUM DIOXIDE EXPOSURES. Gavankar, Harsharaj Ganesh (California Univ., Berkeley). Jun 1972. 99p. Dep. NTIS.

Thesis.

Principal route of entry of plutonium dioxide into the human body is via inhalation of the plutonium-bearing aerosols released from a fast reactor accident. In order to estimate radiation doses, therefore, consideration of the aerosol transport characteristics is necessary along with understanding of the physiology and anatomy of the human respiratory tract, its particle deposition, clearance and translocation processes and their influence on the ultimate fate of inhaled PuO_2. Based on a review of the available long-term experimental data on animals involving inhalation of $^{238}PuO_2$, and the limited ^{239}Pu data in man, the critical organs chosen for dose calculation are: lung, liver, and bone. Although the lymph nodes are an important deposition site for PuO_2 translocated from the lung, no life-shortening attributable to tumors or other lymphatic tissue damage has been demonstrated in experimental animals. On the basis of calculated doses and the extrapolated tumor risk probabilities, per microcurie of initial deposition of $^{239}PuO_2$ in the deep lung, and per microcurie of fifty-year accumulated deposition in the liver and bone, the following $^{239}PuO_2$ dose guidelines are considered to be risk-equivalent to 25 rem whole body exposure: fifty-year accumulated doses to lung, liver, and bone of 10, 25 and 75 rem respectively are separately risk-equivalent to cancer risks believed to be associated with 25 rem whole body exposure; on a total risk basis (tumors for lung + liver + bone), the same reference risk would occur with 0.019 microcurie of inhaled $^{239}PuO_2$ for a typical 0.5μ AMAD aerosol; the resulting 50-year accumulated doses to the lung, liver, and bone of a 20-year old adult will be 7.0 rem, 7.7 rem, and 3.0 rem respectively. Until substantial operating experience is gained on sodium-cooled plutonium dioxide-fueled reactors and until the current low-level dog inhalation experiments initiated in 1970 are completed (about 10 to 15 years from now), this approach may form a rational basis for siting and safety of liquid metal fast breeder reactors. (82 references) (auth)

53512 LEUKEMOGENIC EFFECT OF RADIOSTRONTIUM (^{90}Sr) IN MICE, A COMPARATIVE STUDY OF LEUKEMOGENICITY OF ^{90}Sr AND X RAYS. 1. INCIDENCE AND CHARACTERISTICS OF ^{90}Sr-INDUCED AND X-RAY-INDUCED LEUKEMIAS. Ito, Takaaki (Hiroshima Univ.). Nippon Ketsueki Gakkai Zasshi; 33: No. 4, 415-31(Aug 1970). (In Japanese).

The leukemogenicity of radiostrontium (^{90}Sr) was studied in comparison with that of fractionated whole-body x irradiation in female ICR/JCL mice. A single intraperitoneal administration of ^{90}Sr (1.0 μCi/gm) produced leukemia in 61.8% of the mice, mostly with a latency period of 110 to 240 days. The ^{90}Sr-induced leukemias originated in the peripheral lymph nodes but not in the thymus, although the major radiation injury is restricted to the bone marrow cells. Cytologically, these leukemias were lymphoblastic, reticulum cell, or stem cell type. The occurrence of the leukemia was not affected by thymectomy. The fractionated whole-body x irradiation of 680 R induced leukemia in 77.3% of mice, in which the majority of cases were of thymic origin and cytologically lymphoblastic. Thymectomy was effective in reducing the incidence. Only one case of leukemia (3.0%) occurred among untreated control mice up to 600 days after birth. As to the mechanism of leukemogenesis by both agents, it is postulated that whole-body x irradiation produces leukemic progenitor cells not only in the thymus but also in the bone marrow or spleen and these cells migrate into injured thymus where they proliferate, while ^{90}Sr produces similar progenitor cells in the bone marrow by the internal emission of beta rays and they migrate into peripheral lymphoid tissues but not into intact thymus. Furthermore, x-ray induced leukemic progenitor cells, that are not yet specified for any particular cell type, might be endowed with the capability of lymphoid differentiation in the thymus by an as yet unknown thymic factor. On the other hand, most of the ^{90}Sr-induced leukemic cells that settled in the peripheral lymphoid tissue without passing through the thymic environment might remain as primitive undifferentiated cell type (stem cell or reticulum cell). (auth)

53513 QUANTITATIVE EFFECTS OF ^{131}I ON DIFFERENT TISSUE COMPONENTS IN FOETAL AND GOITROGEN CHALLENGED MOUSE THYROIDS. Walinder, G. (Foersvarets Forskningsanstalt, Stockholm). Acta Radiol., Ther., Phys., Biol.; 11: No. 1, 1-23(Feb 1972).

The effects of radiation on cell number and on the relative amount of tissue components in the thyroid gland were investigated morphometrically in immature mice and in adult, goitrogen-challenged CBA mice at different times after the injection of ^{131}I. Cell survival was examined by measuring residual tritium activity in the glands of mice injected with tritium-labelled thymidine before the administration of radioiodine. The radiation-induced growth arrest of the thyroid tissue appeared to be due mainly to mitotic death of the cells. (auth)

53514 CHANGES OF THE CELLULAR DIVISION AND DNA SYNTHESIS IN GLANDS OF THE GASTRIC FLOOR OF RATS UNDER THE EFFECT OF RADIUM EMANATION. Zaporozhchenko, I. G. (Inst. of Medical Genetics, Moscow). Byull. Eksp. Biol. Med.; 73: No. 4, 95-8(Apr 1972). (In Russian).

Circadian changes of the mitotic index in rat glands of the gastric floor have a high level at 7 a.m. to 4 p.m. and at 8 p.m. The circadian rhythm of the index of labeled nuclei is characterized by the highest levels at 10 a.m. to 2 p.m. and at 10 p.m. In peroral administration of radon water of diverse concentration, alpha-radiation influences the circadian changes of the mitotic index and the index of labeled nuclei in the glands of rat gastric floor. The degree of changes in the proliferation and level of DNA

synthesis depends on the concentration of radon in the water. (auth)

53515 RADIATION DOSE AND RADIOPROTECTIVE EFFECT IN THE EXAMINATION OF THE THYROID GLAND OF BIRDS. Robiller, F.; Unverricht, A. (Friedrich-Schiller-Univ., Jena, Ger.). Radiobiol.-Radiother.; 13: No. 3, 393-6(1972). (In German).

After parenteral injection, the accumulation of ^{131}I was measured over the thyroid gland of different kinds of birds (budgerigar, serin) of both sexes. The radiation dose was determined by Loewinger's method. Despite an organ dose of 12,000 rad, functional or morphological changes of the thyroid gland and a limitation of the generative power could not be observed. (auth)

53516 HEMATOLOGIC CHANGES AND CHANGES IN THE BLOOD PROTEINS IN EXPERIMENTS ON WHITE RATS FOLLOWING INTRATRACHEAL ADMINISTRATION OF RADIOCERIUM. Hecko, I.; Trnovec, T.; Grunt, J.; Kortus, J. (Research Inst. of Hygiene, Bratislava). Bratislav. Lek. Listy; 56: No. 4, 465-72 (Oct 1971). (In Czech).

Several hematologic values, the protein content of blood plasma as well as the elements of this content were ascertained on the 32nd and the 64th days following the placing of ^{144}Ce (of a 3.9 activity of μC on the animal) into the trachea of 5 or 8 experimental white rats. With equally large control groups, altogether 26 rats have been examined. The differences between the experimental and the control groups of rats have been confirmed as statistically significant using five hematologic values (in two on the 32nd day and in three on the 64th day of the experiment): once in the number of leukocytes, twice in the hematocrit value and twice in the indices calculated always from two values of the red blood picture (mean hemoglobin corpuscular concentration and mean corpuscular hemoglobin). The differences between the experimental and the control groups of rats as regards the protein content of the blood plasma (ascertained refractometrically) and in the elements of this content (ascertained by electrophoresis on paper) have not been confirmed as statistically significant. (auth)

53517 INFLUENCE OF RADIOACTIVE PHOSPHORUS (^{32}P) ON THE CHICK EMBRYO DEVELOPMENT, HATCHABILITY, AND CHICK GROWTH. Lee, K. W. Korean J. Anim. Sci.; 13: No. 2, 116-25(1971).

Radioactive phosphorus (^{32}P) in single doses up to 40 μC was injected into the egg yolk during the 5th to 15th incubation day. Embryo development, hatchability and chick growth rate up to 150 days old were observed. A single dose of 5 to 40 μC of ^{32}P on the 5th to 15th incubation day resulted in the significantly retarded development of the 18 day-old chick embryo as the ^{32}P dosage increased. A significant negative correlation between the ^{32}P dosage on the 12th incubation day and hatchability ($r = -0.946$) and a linear regression of hatchability loss to ^{32}P dosage ($Y = 0.372X + 17.06$) were obtained. The chick growth rate up to 150 days old was decreased significantly as the ^{32}P dosage on the 12th incubation day increased. (Korean Sci. Abstr.)

Microorganisms

53518 SPECIFIC ENRICHMENT OF MUTANTS OF ESCHERICHIA COLI WITH AN ALTERED ACYL CoA SYNTHETASE BY TRITIUM SUICIDE. Hill, F. F.; Angelmaier, Doris (Univ., Cologne). Mol. Gen. Genet.; 117: No. 2, 143-52(1972).

In a rich growth medium, tritium-labeled oleate is incorporated preferentially into the lipid fraction of Escherichia coli K 12. The incorporation of the radioactive oleate after a temperature shift kills the majority of the cells during subsequent storage. Most of the surviving cells can no longer grow with oleate as the sole carbon source at 40°C or 30°C, though some exhibit a thermosensitive behavior, and are able to grow at 30°C but not at 40°C. It will be shown that mutants of the first group lack the enzyme acyl CoA synthetase, and that this enzyme is thermolabile in mutants of the second group. In addition, one further mutant was isolated that possessed a normal acyl CoA synthetase but was unable to degrade or incorporate oleic acid. (auth)

Nuclide Kinetics and Toxicology

Refer also to abstracts 53021, 53024, 53149, and 53396.

53519 ANALYSIS OF KINETIC CURVES. APPLICATION OF DATA PROCESSING. Uchikawa, Toru; Fukuda, Nobuo (National Inst. of Radiological Sciences, Chiba, Japan). Sogo Rinsho; 20: No. 8, 1793-9(Aug 1971). (In Japanese).

A brief review is made of kinetic analysis with reference to the results of the analysis of in vivo radioisotope metabolism conducted by the authors. Brownell's symbols are used in accordance with the ICRU recommendation. The parameters of kinetics obtained from the radioactivity-time curves of whole-body, blood, and urine include: turnover rate and turnover time; initial distribution volume; rate of exit from the space of fast initial mixing; fraction of irreversible removal and fraction of re-entry into circulation; and mean transit time. The transfer rate is obtained from the formulation of compartment models exemplified by a mammillary or parallel model, catenary or series model, or the combination of the former two models, i.e., cateno-mammillary model and mammillocatenary model. The effectiveness of this kinetic analysis is conditioned mainly by the kind and quality of data and the proper choice of model. The choice of a model most pertinent to a particular biological system is extremely difficult. Besides only certain kinds of isotopes can be used for this method. Further studies on methodology and the standardization of terminology, that of the Japanese in particular, are expected. (Japan)

Man

Refer also to abstracts 53074 and 53413.

53520 (CEA-N-1535) ^{90}Sr LEVELS IN HUMAN BONES COLLECTED IN 1970. Jeanmaire, Lucien; Patti, Francois (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). May 1972. 25p. (In French). Dep. NTIS (U. S. Sales Only).

The level of ^{90}Sr and stable Sr in human bones collected in the Paris area in 1970 is presented. The general tendency observed is a slight decrease in the level of contamination for all age groups, except that of newborn babies. (France)

53521 POLLUTION TRANSFER TO MAN. PART 2. DYNAMIC STUDY OF THE BEHAVIOR AND TRANSFER OF RADIOACTIVE POLLUTION. Bresson; Bittel; Coulon; (and others) (CEN, Fontenay-aux-Roses, France). Nuisances Environ.; No. 7, 33-9(Jan 1972). (In French).

In order to protect the population from the adverse effects of radiation, it is important to know the relation between the effects (dose delivered) and the cause (level of radioisotopes introduced into the environment). This relation depends upon the mechanism controlling the transport of the radioisotopes and transfer to man, and thus upon the parameters characteristic of this transfer. The way in which the radioisotope is introduced into the environment and removed from different media is examined as well as its behavior in the different media. An inventory of the relevant parameters (mechanical, physical, physicochemical, biological) is presented. The vegetable and animal media, food products, and the materials used by man are studied. (France)

53522 POLLUTION TRANSFER TO MAN. PART 1. DYNAMIC STUDY OF BEHAVIOR AND TRANSFER OF RADIOACTIVE POLLUTION. Bresson; Bittel; Coulon; (and others) (CEN, Fontenay-aux-Roses, France). Nuisances Environ.; No. 6, 33-40(Dec 1971). (In French).

A quantitative inventory of the various characteristics and parameters capable of modifying the transfer to man of radioactive pollutants is presented. An improved protection system is sought. The behavior of a radioactive pollutant in the environment is examined dynamically, i.e. in addition to examining the phenomena intervening in the different media, (atmosphere, soil, water) the characteristics of inter-medium transfer are examined. (France)

53523 DOSE ACTION LEVELS FOR ACCIDENTAL RADIATION EXPOSURE OF THE GENERAL PUBLIC. Voilleque, Paul G. (Health Services Lab., Idaho Falls, Idaho). pp 183-204 of Radiation Protection Standards: Quo Vadis. Vol. I. Howell, Wallace P. (ed.). Richland, Wash.; Health Physics Society (1972).

From 6th annual topical symposium on radiation protection standards: quo vadis; Richland, Wash. (2 Nov 1971).

The problems of establishing criteria for limiting radiation exposure of members of the general public in the unlikely event of a radiological emergency are discussed. The dose limitation criteria, termed Action Levels in ICRP Publication 9, can serve as the foundation for making decisions based on environmental measurements taken during the evaluation of an accidental release of radioactivity from a nuclear facility to its environs. (auth)

53524 AMOUNT AND FORM OF RADIOACTIVITY IN HUMAN MILK AFTER LUNG SCANNING, RENOGRAPHY, AND PLACENTAL LOCALIZATION BY ^{131}I LABELED TRACERS. Karjalainen, P.; Penttilae, I. M.; Pystynen, P. (Kuopio Central Hospital, Finland). Acta Obstet. Gynecol. Scand.; 50: No. 4, 357-61(1971).

The secretion of radioisotope into mothers' milk was studied after the administration of carriers labelled with ^{131}I. The radiopharmaceuticals used were 300 μCi macroaggregated human serum albumin (MAA) (for lung scanning), 25 μCi ortho-iodohippuric acid

(OIH) (for renography), and 10 μCi human serum albumin (HSA) (for placental localization). In the MAA series (7 patients), the maximum radioactivity secreted into milk in the 24 hr following injection was 0.7%, and the mean activity 0.14% of the injected dose. The corresponding figures of the OIH series (25 patients) were 2.4 and 0.32%. In both cases activity was at its maximum during the first 24 hr after injection. In the HSA series (8 patients), the maximum radioactivity secreted into the milk during 24 hr after injection was 0.22% of the injected dose. After the administration of OIH and apparently also of MAA, the radioactivity secreted in 24 hrs increases if the excreted volume of milk increases. The ^{131}I secreted in the milk was not bound to the radiopharmaceutical originally administered, but was mainly in the form of free isotope. The breast feeding of babies whose mothers had undergone lung scanning, renography, or placental localization was discussed. It was proposed that milk should be discarded for a minimum of 7 days following lung scanning and a minimum of 2 days following renography, provided the examinations were carried out by means of the radiopharmaceuticals and doses used by the present authors. (auth)

53525 ^{226}Ra IN POLISH DIET AND FOODSTUFFS. Pietrzak-Flis, Zofia (Central Lab. for Radiological Protection, Warsaw). Nukleonika; 17: No. 3-4, 227-31(1972).

Contents of ^{226}Ra and calcium were determined in diet, some foodstuffs, and urine, collected in the Kowary Valley, and in some foodstuffs and urine collected in the Warsaw region. The content of ^{226}Ra in diet in the Kowary Valley was about 0.58 ± 0.04 pCi/day, the contribution from water being about 0.30 pCi/day. The mean ^{226}Ra content in foodstuffs from the Kowary Valley was about three times higher than that in foodstuffs from the Warsaw region. The ^{226}Ra content in urine collected in Kowary was about two times higher than that in urine collected in Warsaw. (auth)

Animals

Refer also to abstract 53515.

53526 (BNWL-tr-71) MECHANISMS OF HEPATIC UPTAKE OF HEPATOTROPIC RADIONUCLIDES. Trnovec, Tomas; Plaskova, Anna. Translated for Battelle Pacific Northwest Labs., Richland, Wash., from Prac. Lek.; 23: No. 5, 175-81(1971). 20p. Dep. NTIS.

A survey concerning the mechanism of the uptake of radionuclides in the liver is presented. The mechanism of hepatic uptake of polymerizable radionuclides depends markedly on the physicochemical condition in which they exist in the blood. Both principal types of liver cells, i.e. parenchymal and Kupffer cells, take part during uptake of the radionuclides of rare earths and transuranium elements into the liver. Emphasis is placed on the uptake of ^{239}Pu and ^{241}Am by the liver of mammals. Further investigation of the mechanism of hepatic uptake of polymerizable radionuclides must begin with the latest discoveries concerning the morphology and physiology of the liver tissue. Such discoveries, from a point of view of association between these radionuclides and plasma proteins are, for example, findings concerning the metabolism of isologous proteins in the liver cells. (auth)

53527 (FOA-4-4503-A-3) TRANSFER OF SIMULATED FALLOUT-PARTICLES FROM PASTURE TO GRAZING DAIRY CATTLE. I. INTRODUCTORY EXPERIMENTS WITH WET DEPOSITED 100 TO 200 μm PARTICLES. Auraldsson, Hans-Ake; Ekman, Lars; Eriksson, Ake; Greitz, Ulf (Forsvarets Forskningsanstalt, Stockholm (Sweden)). Jul 1972. 18p. Dep. NTIS (U. S. Sales Only).

When estimating internal radiation risks in a local fallout area knowledge of the transport of fallout particles from pasture to grazing cows is essential. The present report deals with the design of grazing experiments in order to test their suitability to determine simulant fallout particle transport to cows. The principle of the experiments was that labeled (^{140}La) silica sand particles 100 to 200 μm in diameter were deposited in a water suspension on pasture where cows were kept grazing. The fraction of the deposition ingested by the animals was assessed by assay of the radioactivity content in feces. It was found that the differently designed experiments gave similar results. About twenty percent of the wet deposited particles were consumed by the grazing cows. For further studies of the transport of close-in particulate fallout simulant one type of experiment was found to be the most suitable. It gives information on the fraction of particles consumed by the grazing cows during the first two days after deposition when the retention of particles on the grass is high. (auth)

53528 (LF-tr-71) PULMONARY LAVAGE, THERAPY OF PULMONARY CONTAMINATIONS. Kunzle-Lutz, M.; Metivier, H.; Nolibe, D.; Simon-Vermot, A.; Gimbert, J. L.; Jockey, P. Translated by A. A. Horvath (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.), from Poumon Coeur; 26: 1029-38(1970). 10p. Dep. NTIS.

An abstract of this article was prepared from the original language publication and appears in NSA Vol. 26 as number 9528. (C.H.)

53529 (NASA-TM-X-2440, pp 982-8) HAIR RADIOACTIVITY AS A MEASURE OF EXPOSURE TO RADIOISOTOPES. Strain, W. H.; Pories, W. J.; Fratianne, R. B.; Flynn, A. (Cleveland Metropolitan General Hospital. Case Western Reserve Univ., Cleveland). Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

Measurement of hair radioactivity appears to be a suitable method for monitoring systemic exposure to radioisotopes and certain types of manmade radiation. This concept has developed from a suggestion we made in 1963 that the strontium-90 content of hair affords a nondestructive method of estimating the body burden of this radionuclide. Since many radioisotopes accumulate in hair, this tropism was investigated by comparing the radioactivity of shaved with plucked hair collected from rats at various time intervals up to 24 hrs. after intravenous injection of about 5 μCi of the ecologically important radioisotopes, iodine-131, manganese-54, strontium-85, and zinc-65. The plucked hair includes the hair follicles where important biochemical transformations are taking place. The data indicate a slight surge of each radioisotope into the hair immediately after injection, a variation of content of each radionuclide in the hair, and a greater accumulation of radioactivity in plucked than in shaved hair. These results have application not only to hair as a measure of exposure to radioisotopes, but also to tissue damage and repair at the hair follicle. (auth)

53530 (TID-3915(Suppl.1)) RUSSIAN RADIOECOLOGY: A BIBLIOGRAPHY OF SOVIET PUBLICATIONS WITH CITATIONS OF ENGLISH TRANSLATIONS AND ABSTRACTS. Klement, Alfred W. Jr. (Division of Radiological and Environmental Protection (AEC), Washington, D. C.); Schultz, Vincent (Washington State Univ., Pullman. Dept. of Zoology). Sep 1972. 70p. Dep. NTIS.

A list is presented of 646 annotated references to Soviet publications in the field of radioecology. English translations of all titles are included and citations to available English abstracts and translations are given. Publications that discuss the distribution, effects, and utilization of radioisotopes in animals and plants in freshwater, marine, and terrestrial environments; ecological techniques employing radioisotopes; and laboratory studies having applications in ecology are included. (C.H.)

53531 (UCRL-Trans-1477) EXPERIMENTAL STUDY OF DECONTAMINATION OF THE SKELETON AFTER INHALATION OF AMERICIUM NITRATE. Nenot, J. C.; Morin, M.; Lafuma, J. Translated by Howard G. Parker (Univ. of California, Lawrence Berkeley Lab.), from Health Phys.; 21: 395-400(1971). 11p. Dep. NTIS.

An abstract of this article was prepared from the original language publication and appeared in NSA Vol. 25 as number 49092. (C.H.)

53532 RADIATSIONNAYA I KHIMICHESKAYA EKOLOGIYA GIDROBIONTOV. (Radiation and Chemical Ecology of Hydrobionts). Polikarpov, G. G. (ed.). Kiev; Izdatel'stvo Naukova Dumka (1972). 120p.

Eleven papers by different authors are included. The first part, the Physical Chemistry of Radionuclide Uptake by Sea Organisms, is particularly concerned with the transport of ^{65}Zn in sea water, its uptake by animals and plants, and the mathematics of radionuclide exchange between sea organisms and their environment. The second part, A Search for a Biochemical Storage Point for Radionuclides in Hydrobionts, includes eight papers on alginic acid, hydrolysis of some alginates, and the relation of alginic acid to uptake of ^{90}Sr by animals and plants and possible mechanisms for the fixation of radionuclides in connection with alginic acid. (K.S.W.)

53533 CHANGES IN THE DISTRIBUTION OF ^{137}Cs IN RABBITS DURING PERITONEAL DIALYSIS. Dziuk, Eugeniusz (Osrodek Ochrony Radiologicznej i Radiobiologii, Warsaw). Nukleonika; 16: No. 11-12, 583-9(1971). (In Polish).

The investigation on 30 rabbits (in three groups) contaminated intravenously with ^{137}Cs was carried out. In two groups, 15 min after the contamination, peritoneal dialysis was started; continuous and intermittent method being used. While dealing with the dialysis of animals, the speedier removing of ^{137}Cs from blood than took place in a control group was noticed. After 120 min, the animals were killed and the samples of tissue were taken. The content of ^{137}Cs in skeletal muscles, myocardium, and liver

hasn't differed among individual groups. But changes in the distribution of ^{137}Cs in the kidneys were noticed. The removal of ^{137}Cs with urine and with dialyzing fluid was also estimated. (auth)

53534 LONG-TERM RETENTION OF RADIOBARIUM AND RADIOSTRONTIUM IN RABBITS. Liniecki, Julian; Karniewicz, Wieslawa (Inst. of Occupational Medicine, Lodz, Poland). Nukleonika; 16: No. 11-12, 591-604(1971).

Whole-body retention of single doses of ^{90}Sr and ^{133}Ba was followed for about 1000 days in rabbits. The data were fitted to a series of exponentials and a modified power function $R_t = A(\epsilon + t)^{-b}$. When the latter function was used, a poor fit was obtained at times beyond about 300 days after injection of the nuclides; when excretion became much slower than predicted by the parameters of the initial power function. This slowly eliminated fraction of alkaline earth traces had a mean residence time in the skeleton of several thousand days. From comparison of whole body retention and plasma clearance data for Sr and Ba it follows that a long-term preferential residence, due to the positive discrimination in the initial uptake of Ba(Ra) against Sr(Ca) into the skeleton, operates in this species. (auth)

53535 BALANCES OF ^{137}Cs, STABLE CESIUM, AND POTASSIUM OF BLUEGILL (LEPOMIS MACROCHIRUS RAF.) AND OTHER FISH IN WHITE OAK LAKE. Kolehmainen, S. E. (Oak Ridge National Lab., Tenn.). Health Phys.; 23: No. 3, 301-15 (Sep 1972).

Concentrations of ^{137}Cs, stable cesium, and potassium, and the intake and elimination rates of these nuclides were determined in bluegill and six other species of fish inhabiting a small radioactively contaminated lake in Oak Ridge, Tennessee during the period from June 1967 to January 1969. Cesium-137 concentrations increased by a factor of four in bluegills from 1 to 70 g, but the concentration of stable cesium decreased slightly with increasing fish size. In all species, the concentrations of ^{137}Cs cycled seasonally with a minimum in summer and a maximum in winter. Radiocesium concentration was highest in species feeding on food from which a high percentage of ^{137}Cs was absorbed. The concentration of stable cesium cycled similar to that of ^{137}Cs. Concentrations of potassium decreased somewhat with increasing fish size, but did not fluctuate seasonally. There were only small differences in the concentration of potassium in different species. The specific activities of ^{137}Cs in fish were in the same ranges as the specific activity of ^{137}Cs in water. In bluegill, the absorbed ^{137}Cs was eliminated by a two-component exponential process. Potassium was eliminated at a single exponential rate, 0.019/day at 15°C in bluegill. The absorption of potassium was almost complete for all types of food. Intake rates of ^{137}Cs, stable cesium, and potassium in bluegill were calculated on the basis of seasonal changes in body burden and elimination rates of these nuclides. (auth)

53536 RELATIVE NONHOMOGENEITIES OF RADIATION DOSE TO THE RESPIRATORY TRACT FROM INHALED RADIONUCLIDES. Barnes, J. E.; Hulbert, A. J.; Osborn, L. A. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). pp 96-116 of Radiation Protection Standards: Quo Vadis Vol. I, Howell, Wallace P. (ed.). Richland, Wash.; Health Physics Society (1972).

From 6th annual topical symposium on radiation protection standards: quo vadis; Richland, Wash. (2 Nov 1971).

Knowledge of the distribution of inhaled radionuclides along the respiratory tract is essential to evaluating the resultant radiation dose and potential biological effect. To obtain such information, Beagle dogs were exposed to a variety of aerosols in several different forms, sacrificed, frozen and sectioned. Autoradiographs of sections through upper respiratory tract show the accumulation of material in the turbinates and the nasopharynx. Autoradiographs of thoracic sections were analyzed with a scanning microdensitometer. Computer techniques were used to yield isodose contour mappings of the radiation dose distribution. The homogeneity of the lung dose from inhaled ^{90}Sr fused clay, a pure beta-emitter, is described. A nonhomogeneous accumulation of inhaled radionuclides in a striated pattern near the costal surface of the lung was also studied. This was observed autoradiographically and apparently results from the influence of the ribs during respiration. The phenomenon was observed in dogs sacrificed from within 10 minutes to as late as 768 days after exposure to a relatively insoluble aerosol. It was also observed in the lungs of a Rhesus monkey after inhalation. Gross biological lesions on the costal lung surface were observed which correlate with the striated pattern of activity accumulation. A subpleural accumulation of carbon particles in a similar striated pattern has been reported in human lungs at autopsy. The significance of these phenomena to lung burden measurements and hazard evaluation is discussed. (auth)

53537 STIMULATION OF RENAL ORGANIC BASE TRANSPORT BY URANYL NITRATE. Hirsch, G. H. (Health Protection Branch Research Labs., Ottawa). Can. J. Physiol. Pharmacol.; 50: No. 6, 533-9(Jun 1972).

Administration of 6 mg/kg uranyl nitrate to adult male rats resulted in a significant enhancement of N-methylnicotinamide (NMN) uptake by renal cortical slices when measured 24 or 48 hr after injection. The accumulation of another organic base, tetraethylammonium (TEA), by renal cortical slices was also significantly increased by uranyl nitrate treatment, but transport of the organic acid p-aminohippurate (PAH) was not altered in these experiments. The kidney weight to body weight ratio was increased in treated rats. Accumulation of NMN by renal cortical slices was significantly enhanced within 8 hr after administration of 6 mg/kg uranyl nitrate. NMN uptake was also significantly enhanced 24 and 48 hr after administration of 0.5 or 1.0 mg/kg uranyl nitrate to rats. The nephrotoxicity produced by uranyl nitrate was not directly related to its induction of organic base transport. The data support the hypothesis that the organic base transport system can be selectively induced by appropriate stimuli. Treatment of rats with potassium chloride did not enhance NMN uptake by renal cortical slices. (auth)

53538 STUDIES ON ARSENIC METABOLISM. 1. A STUDY ON THE DIFFERENCES IN ANIMALS IN ^{74}As UPTAKE. Tsutsumi, Shoji (Tokyo Dental Coll.). Nippon Shonika Gakkai Zasshi; 75: No. 9, 897-906(Sep 1971). (In Japanese).

Oral administration of ^{74}As was given to rabbits, rats, and mice to study its incorporation into various tissues of the animals and the subsequent fate in the course of time. In rabbits, radioactive concentration reached highest levels in 2 hrs in all tissues except hair. The liver obtained the highest concentration. The concentration per 1 mg of tissue was in the decreasing order of lung, liver, kidney, spleen, and brain. Hair was slightly higher in concentration than were muscle, skin, nail, femur, mandibula, molars, and incisors which were all low. Excretion of the radioactive substance was rapid. The concentration per 1 ml of blood was also low. In rats, the highest value was obtained in 2 to 6 hrs after administration. The concentration by organ was highest in the liver. Radioactive pool on the 24th day was in the decreasing order of lung, liver, spleen, heart, and kidney and extremely small in femur, mandibula, incisor, molar, and brain. Greatest uptake per 100 mg of tissue was observed in the spleen, followed by kidney, lung, liver, heart, femur, incisor, mandibula, molar, and skin in contrast to extremely small amounts in hair, muscle, and brain. The disappearance of the radioactive element was generally slow. Blood concentration per 1 ml was fairly high, the disappearance of radioactivity being also slow. In mice, uptake reached highest levels in 2 to 6 hrs in most organs. Nails ranked top in concentration per 100 mg of tissue. More than 1% of the radioactivity remained in nail, molar, and hair even after 5 days. Radioactivity disappeared in the order of spleen, incisors, mandibulas, muscle, femur, heart, lung, brain, kidney, and liver. Blood concentration per 0.1 ml was lower than rats and the disappearance of radioactivity from blood was also rapid. More ^{74}As was detected in the digestive tract of mice compared with rats until 6 hrs after administration, but was remarkably reduced in 24 hrs to levels lower than in rats. Almost no change was observed after 5 days. In rats, the concentration in urine was slightly higher than in feces. (Japan)

Plants

53539 (SRO-641-4) RADIOACTIVE TRACER STUDIES OF SOIL AND LITTER ARTHROPOD. Progress Report, November 1, 1971–October 31, 1972. (Georgia Univ., Athens. Dept. of Entomology). 1 Aug 1972. Contract AT(38-1)-641. 32p. Dep. NTIS.

The movement of potassium and calcium in the arthropod food web of a forest floor was quantified, using ^{134}Cs and ^{85}Sr as tracers for K and Ca. Four models were developed, a summer and an annual model for each element. On an annual basis, Oribatid mites (Cryptostigmata) were found to be the most important saprovore for elemental movement from decomposing litter. Cryptostigmata were second in importance to millipedes when summer seasons were considered alone. Evaluation of a recent model for retention and assimilation of radioactive tracers demonstrated the value of dual tagging with nonassimilated ^{51}Cr. The usual two-component model describing retention was shown to yield estimates of assimilation as a rate function, provided good measurements were obtained for the gut clearance rate. Measurements of fallout ^{137}Cs in plant species from granitic outcrops in Georgia confirm the values reported in 1965. (auth)

53540 INFLUENCE OF CLINOPTILOLITE ON ^{90}Sr AND ^{137}Cs UPTAKES BY PLANTS. Nishita, H.; Haug, R. M. (Univ. of California, Los Angeles). Soil Sci.; 114: No. 2, 149-57(Aug 1972).

An experiment was conducted to determine the effect of clinoptilolite on the ^{90}Sr and ^{137}Cs contents of bean and barley plants grown in soils contaminated at the surface (experiment I). An experiment was also conducted to determine the release of ^{90}Sr and ^{137}Cs to clover plants upon continuous and prolonged cropping of a contaminated soil with and without clinoptilolite treatment (experiment II). In experiment I, clinoptilolite was found to decrease the average ^{90}Sr contents of plants. The percentage reduction of ^{90}Sr contents of the different parts of the bean plants ranged from 48 to 70, 54 to 77, and 44 to 77% in the leaves, stems, and fruits, respectively, depending on the amount of clinoptilolite application and the kind of soil. The percentage reduction of ^{90}Sr in barley plants under various treatments ranged from 57 to 77 and 57 to 79 for the leaves and stems and the heads, respectively. In experiment II, eight harvests of clover were obtained. The application of Ca-treated clinoptilolite was effective in reducing ^{90}Sr contents of the plants grown in the mineral soil used, but it had no effect in the organic soil. Depending on the harvest time, the average ^{90}Sr contents of the plants grown in the treated mineral soil were 59 to 69% less than that of the control plants. Clinoptilolite was effective in maintaining the reduced ^{90}Sr contents of the plants throughout the experimental period. The ^{137}Cs contents of the plants were not changed appreciably by the application of clinoptilolite. (auth)

New Tracer Techniques

Refer also to abstracts 53214, 53413, 53539, 55058, and 55457.

53541 (TID-26128) MEDICAL RADIOISOTOPES MANUAL. (Oak Ridge Associated Universities, Inc., Tenn. (USA). Special Training Div.). 1971. 220p. Dep. NTIS.

This manual was prepared for use in a training course on the uses of radioisosopes in medicine. Twenty-four experiments cover the characteristics of β and γ radiations, radiation safety principles and monitoring instruments, radiation counting instruments and techniques, radioisotope scanning, in vitro diagnostic tests, and related subjects. Pertinent information on radiation safety rules, a classification of radioisotopes, sources of materials, and a list of reference books is included. (C.H.)

53542 VISUALIZATION OF ARTERIAL AND ARTERIAL GRAFT PATENCY BY INTRAVENOUS RADIONUCLIDE ANGIOGRAPHY. Meindok, H. (Toronto Western Hospital). Can. Med. Ass. J.; 106: No. 11, 1180-2(10 Jun 1972).

A method of visualizing patency of arteries and arterial grafts by means of intravenous ^{99m}Tc-pertechnetate using a Nuclear Chicago Pho/Gamma HP camera is described. Gamma camera polaroid pictures showing normal arteries in the upper and lower limbs as well as partial and complete occlusion of arteries and the state of arterial bypass grafts in pre- and postoperative patients are compared with conventional arteriograms. The advantages and limitations of this method are discussed. Intravenous radionuclide arterioradiography exposes the patient to 0.14 rads of whole-body radiation and 1.3 rads to the colon per 10 mc injection of ^{99m}Tc-pertechnetate. (Canada)

53543 DETERMINATION OF THE SYSTOLIC VOLUME BY EXTERNAL COUNTING. A MODEL FOR CALIBRATING THE CURVES. Zwirn, P.; Sebaoun, E.; Franceschi, A.; Fondarai, J. (Univ., Marseille). Ann. Phys. Biol. Med.; 6: No. 2, 79-86 (1972). (In French).

The recording of the variations in the volume of blood flow in the heart using ^{131}I and external counting techniques enabled curves representing the evolution of the cardiac volume to be obtained during the heart cycle. Experiments were performed on a model in order to develop a calibration method. In this way, it was possible to determine the parameters for calibrating the volume variation curves. However, when in vivo measurements are considered (in which all the conditions can not be controlled), the accuracy obtained is diminished. This case corresponds to the in situ heart, the volume variation being affected by the radioactivity of the surrounding tissues. (France)

53544 READING, AUTOMATIC TREATMENT, AND VISUAL DISPLAY OF RADIOACTIVITY SPECTRA RECORDED ON PUNCHED TAPE; APPLICATION TO THE STUDY OF THE METABOLISM OF TWO IN-VIVO RADIOISOTOPES. Soussaline, F.; Parmentier, C.; Bazin, J. P. (Institut Gustave Roussy, Villejuif, France). Ann. Phys. Biol. Med.; 6: No. 2, 53-68 (1972). (In French).

A completely automatic method for analyzing radioactivity spectra is described. The method facilitates the checking of the supporting data tapes, their computer treatment, and their visual display using a digital plotter. The method is applied to the analysis of the spectra of an $^{59}Fr/^{51}Cr$ mixture recorded by external counting during a double labeling test. The spectral shift correction technique utilized involves the fitting of these spectra by an orthogonal polynominal sum. This method, which is accurate and sufficiently fast to be used as a routine technique, eliminates all errors due to the detector, nonlinearities of the analyzer, or electronic instabilities. The spectral subtraction realized in this way enables the examination period to be shortened when ^{51}Cr is injected into the body. The scattered γ ray spectrum of the ^{59}Fe presents little distortion. (France)

MATERIALS

Ceramics and Cermets

Refer also to abstracts 52893, 53039, 53067, 53317, 53601–53603, 53617, 53620, 53632, 53651, 53704, 55022, 55027, 55031, 55032, 55035, 55189, and 55190.

53545 (ANL–7945) DEFORMATION AND FRACTURE OF UO_2–20 WT PERCENT PuO_2. Roberts, J. T. A.; Wrona, B. J. (Argonne National Lab., Ill.). Jun 1972. Contract W-31-109-eng-38. 39p. Dep. NTIS.

The four-point bend strength of UO_2–20 wt % PuO_2 was measured as a function of temperature and strain rate. The brittle-fracture stress was limited by fabrication flaws and/or impurities and was therefore relatively insensitive to changes in microstructure. The brittle-to-ductile transition temperature T_C increased with a reduction in porosity and an increase in applied strain rate. Above T_C, specimens generally exhibited extensive ductility, and a steady-state flow stress was maintained throughout the test. Based on the equivalence of steady-state flow and creep, T_C was described in terms of the brittle-fracture stress and the compressive creep strength. This allowed us to examine the sensitivity of T_C to fission rate and strain rate over a wide range, and it introduced an additional condition for fuel cracking into the LIFE-II code cracking subroutine. Thus, for cracking to occur now, at any instant in time, any of the principal stresses must exceed the fracture stress, and the zone-boundary temperature must be below T_C. The implications of the modified cracking model are discussed, and a typical predicted fuel history in-reactor is described. (auth)

53546 (AREAEE–134) PREPARATION OF SINTERABLE URANIUM DIOXIDE. Haroun, N. A.; Aly, M. M. E.; El-Adham, K. A. (Atomic Energy Establishment, Cairo (Egypt). Dept. of Metallurgy). 1972. 28p. Dep. NTIS (U. S. Sales Only).

Factors affecting the preparation of sinterable uranium dioxide powders have been extensively and critically reviewed. Experimental work on the reduction of ammonium polyuranate (APU) to UO_2, stabilization by cooling in different media, storage behavior, characterization, and sinterability of the resulting oxides is described. Results indicated that the more stable the powders the higher the reduction temperature. However the deterioration of powder activity and sinterability for the higher temperature preparations led to the choice of an optimum temperature of reduction. Of the cooling media investigated: ethyl alcohol-laden nitrogen (and nitrogen) were more effective than argon and hydrogen in stabilizing the powders. Differential thermal analysis was found most suitable for characterizing the powders. (69 references). (auth)

53547 (AREAEE–135) DENSIFICATION OF URANIUM DIOXIDE: A LITERATURE REVIEW. Haroun, N. A. (Atomic Energy Establishment, Cairo (Egypt). Dept. of Metallurgy). 1972. 27p. Dep. NTIS (U. S. Sales Only).

Factors affecting the densification of UO_2 are extensively reviewed. It was concluded that low-temperature sintering of nonstoichiometric oxides in neutral atmospheres is most promising. Variables discussed include, process variables, physical and physicochemical variables, and chemical variables. (101 references). (auth)

53548 (AREAEE–139) FACTORS AFFECTING THE REDUCTION OF URANIUM TRIOXIDE POWDERS. El-Shanshoury, I. A.; Bishay, A. F. (Atomic Energy Establishment, Cairo (Egypt). Dept. of Metallurgy). 1972. 22p. Dep. NTIS (U. S. Sales Only).

The reduction of uranium trioxide powders was investigated using ammonia gas as a reducing atmosphere. The effect of flow rate and particle size was also studied for ammonia and hydrogen reductions. Hydrogen reduction was found to be more effective than that of ammonia. This is attributed to the cracking of ammonia into the reactor during the reduction process. Fine particles reduced much faster than coarse ones. A linear relation between the average particle size of the trioxide powders and the time to reach a certain reduction value is presented for hydrogen reduction. The importance of surface area in the reduction of powders was shown by the presence of surface area concentration in the kinetic rate equation applied in this investigation. (auth)

53549 (EUR–4765, pp 343-63) NON-CONGRUENT VAPORIZATION STAGE OF LANTHANUM OXIDE ON FIRST HEATING TO HIGH TEMPERATURE. Trevisan, G.; Depaus, R. (CCR-Euratom, Petten, Netherlands).

From 2nd conference on mass spectrometry; Ispra, Italy (1 Sep 1971).

Results of isothermal vapor pressure measurements on La_2O_3 carried out using a high temperature mass spectrometer are reported. It was found that the increase of vaporization rate during the first heating period is the result of CO overloss; the increased vaporization rate is proportional to the initial hydroxide content of the sample. (J.R.D.)

53550 (IS-T–540) HIGH TEMPERATURE OXIDATION OF GADOLINIUM AND DYSPROSIUM UNDER CONTROLLED OXYGEN PARTIAL PRESSURE. Basler, D. B. (Ames Lab., Iowa). Aug 1972. Contract W-7405-eng-82. 77p. Dep. NTIS.

Thesis.

The oxidation of gadolinium and dysprosium was studied under controlled oxygen partial pressures in the temperature range 727 to 1327°C. The oxygen partial pressure range was $10^{-0.3}$ to $10^{-14.5}$ atm. Weight gain as a function of time was measured through the use of a thermobalance. From the plots of rational scaling rate constant versus ln P_{02}, it may be inferred that Gd_2O_3 exhibits p-type semiconductivity at oxygen pressures above $10^{-9.4}$ atm in the temperature range 727 to 1177°C and that Dy_2O_3 exhibits p-type semiconductivity at oxygen pressures above $10^{-11.3}$ atm in the temperature range 727 to 1327°C. Utilizing the Wagner parabolic oxidation theory in the semiconducting range, self-diffusion coefficients of oxygen in Gd_2O_3 and Dy_2O_3 were found. The results are described by the relations $D = 1.149 \times 10^{-7} \exp(-40{,}269/RT)$ cm^2/s for Gd_2O_3 (727 to 1177°C), and $D = 2.831 \times 10^{-8} \exp(-21{,}393/RT)$ cm^2/s for Dy_2O_3 (727 to 1327°C). (auth)

53551 (MDC G–3153) PLUTONIA/CURIA COMPATIBILITY TESTING. Quarterly Report No. 15, April–June 1972. Watrous, J. D. (McDonnell Douglas Astronautics Co., Richland, Wash. Donald W. Douglas Labs.). Jul 1972. Contract AT(45-1)-2138. 41p. Dep. NTIS.

Compatibility tests with plutonia-238 in refractory metal capsules have shown that Mo–46 Re is the best container material in exposures at 1800°C for 15,000 to 18,000 hours. Rhenium is also adequate but results in greater transport of plutonia within the container. Compatibility tests of plutonia–molybdenum cermets (PMC) and plutonia–thoria–molybdenum cermets (SSC) in double layer refractory containers at 1500, 1800, and 2000°C resulted in complex interactions. The SSC fuel form was equivalent to the PMC fuel form in helium release, degraded more structurally, but indicated less aggressive attack on the container materials. TZM and Mo–46 Re appeared to provide the best structural containment at 1500 and 1800°C. T-111 appeared inadequate in all tests conducted at these temperatures. Plutonia and PMC fuel aging specimens with curium-242 additions to accelerate helium generation will complete exposure and be examined during the next quarter. Systems oriented tests are being prepared for the Multi-Hundred Watt Thermoelectric Generator Program with exposure to commence during the next quarter and initial results before the end of the calender year. (auth)

53552 (ORNL–4794, pp 45-51) DEVELOPMENT OF THE THORIUM FUEL CYCLE. Aug 1972.

In Chemical Technology Division annual progress report for period ending March 31, 1972.

Research progress is reported on: sol-gel process development for preparation of microspheres, engineering demonstration of the preparation of UO_2 microspheres, process development for the preparation of microspheres using ion exchange resins, preparation of test materials, and ^{233}U storage, purification, and distribution. (D.H.M.)

53553 (ORNL–4794, pp 52-3) PREPARATION OF $^{233}UO_2$ FOR LIGHT-WATER BREEDER REACTORS. Aug 1972.

In Chemical Technology Division annual progress report for period ending March 31, 1972.

Research progress is reported on: process development and flowsheets, design and installation of equipment for the UO_2 conversion line, and plant safety. (D.H.M.)

53554 (ORNL–4794, pp 84-7) PREPARATION AND PROPERTIES OF ACTINIDE OXIDES. Aug 1972.

In Chemical Technology Division annual progress report for period ending March 31, 1972.

Research progress is reported on: oxidation–reduction studies of uranium–plutonium oxides, development of the UO_2–PuO_2 sol-gel process, thoria desintering studies, and preparation of carbides and carbonitrides. (D.H.M.)

53555 (RD/B/N-2214) EXAMINATION OF IRRADIATED UO_2 HTR FUEL PARTICLES. PART I. EXPERIMENTAL TECHNIQUES. Bathe, J. E.; Simpson, K. A. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Jun 1972. 17p. Dep. NTIS (U. S. Sales Only).

The experimental techniques used for the preparation and examination of irradiated UO_2 HTR fuel particles by x-radiography, metallography, scanning electron microscopy, and electron probe microanalysis are described. The studies are designed to provide detailed information on a limited number of fuel particles. (auth)

53556 (SC-CR-723158) STRUCTURAL AND THERMODYNAMIC PROPERTIES OF THE Sc-H SYSTEM. Lundin, Charles E. (Denver Research Inst., Colo.). [nd]. 17p. Dep. NTIS.

The Sc-H system was investigated by metallographic, x-ray diffraction, and Sievert's techniques to define the structural and thermodynamic properties. Phase boundaries were delineated and the saturated phases identified by metallographic and x-ray diffraction analysis. These data were correlated with values deduced from the pressure-temperature-composition relationships as determined by Sievert's technique. The gas-solid equilibria were studied in the temperature range of 450 to 750°C, the pressure range of 5×10^{-5} to 760 torr, and a composition range of from 0 to 66-⅔ atomic percent hydrogen. The dissociation pressure equation was obtained by a least squares analysis and found to be: $\log_{10} p\ (\text{torr}) = (-10{,}300 \pm 300/T) + 10.17 \pm 0.09$. The calculated heat of reaction of the dihydride phase from the saturated solid solution is $\Delta H = -47.1 \pm 1.4$ kcal/mole and the entropy of reaction is $\Delta S = -33.4 \pm 0.4$ cal/mole degree. (auth)

53557 (SC-DC-721080) DYNAMIC FRACTURE BEHAVIOR OF BORSIC-Al COMPOSITES. Hoover, W. R.; Allred, R. E. (Sandia Labs., Albuquerque, N. Mex.). 1972. 16p. (CONF-720709-1). Dep. NTIS.

From International conference on dynamic crack propagation; Bethlehem, PA. (9 Jul 1972).

The impact behavior of unidirectional Borsic-Al composites has been studied using an instrumented Charpy system. In order to experimentally determine the most appropriate impact failure criterion for these composites, dynamic load-deflection traces were obtained under plane strain conditions. Specimens with crack length to width ratios (a/W) from 0.15 to 0.65 and crack root radii from 0.002 in. to 0.036 in. were utilized. Results indicated that the dynamic fracture toughness was independent of crack length over an a/W range of from about 0.20 to 0.50 while other fracture criteria such as the dynamic fracture stress, the strain to fracture, and the energy absorbed per unit area of fracture surface varied continuously with crack length. Results also indicated that over the range of root radii studied, the dynamic fracture toughness was independent of crack acuity. Consequently, the dynamic fracture toughness appears to be an appropriate impact failure criterion for Borsic-Al composites and has been used to study the effects of fiber-matrix bond strength and Borsic volume fraction. In addition, the dynamic behavior of these materials has been compared with their behavior during slow bend tests. (auth)

53558 (UCRL-51244) LITERATURE SURVEY OF METALLIC TERNARY AND QUATERNARY HYDRIDES. Newkirk, Herbert W. (California Univ., Livermore. Lawrence Livermore Lab.). 28 Jun 1972. Contract W-7405-Eng-48. 22p. Dep. NTIS.

The unclassified literature was reviewed to find reported metallic ternary and quaternary hydride compounds of the type $MM'H_x$; M' is a transition element, and M is a transition element, a member of the rare earth series or a member of the actinide series. A summary is presented of some of their most important properties. (auth)

53559 EFFECTS OF IMPURITIES ON THE MIGRATION OF LENTICULAR PORES IN UO_2. Oldfield, William (Materials Research and Computer Simulation, Westerfield, Ohio); Markworth, Alan J. Scr. Met.; 6: No. 8, 757-62(Aug 1972).

Results of studies are presented on the effects of artificially implanted impurities on the behavior of pores in unirradiated UO_2 subjected to a temperature gradient. It was found that the rates of nuclear fuel restructuring related to pore migration can be reduced by suitable impurities added to the fuel during fabrication. (J.R.D.)

53560 STUDY OF THE FORMATION OF TUNGSTEN CARBIDE IN THE FIELD-ION MICROSCOPE. Richman, M. H. (Brown Univ., Providence, R. I.). pp 453-76 of Applications of Field-Ion Microscopy in Physical Metallurgy and Corrosion. /Hochman, R. F. (ed.). Atlanta; Georgia Inst. of Tech. (1969).

From Conference on applications of field-ion microscopy in physical metallurgy and corrosion; Atlanta, GA. (15 May 1968). See CONF-680570.

Equipment and methods used in experiments conducted to carburize tungsten, in field-ion microscopes are described. Results of experiments are analyzed and used as the basis for concluding that detailed studies can be made of compound formation, interfaces between compounds and solid solutions, and diffusion by use of a combination of in situ compound formation and electron diffraction and microscopic techniques. (J.R.D.)

53561 FORMATION OF A PHASE Nb_xO_2 ($0.8 \leq x \leq 1.0$) UNDER SHOCK COMPRESSION OF NIOBIUM PENTOXIDE. Adadurov, G. A.; Breusov, O. N.; Dremin, A. N.; (and others) (Inst. of Chemical Physics, Chernogolovka, USSR). Dokl. Akad. Nauk SSSR; 202: No. 4, 864-7(1 Feb 1972). (In Russian).

When Nb_2O_5 was subjected to compression shock waves of the order of 1.5 Mbar, x-ray studies of the product indicated that it was not one of the previously known polymorphic modifications of Nb_2O_5, but a variable composition Nb_xO_2. Conditions of the experiment could be altered so as to produce a practically continuous transition with respect to composition from a Nb_2O_5 structure to NbO_2. Using containers of different materials, high pulse pressures, high pressure gradients, and high residual temperatures, led to a wide range of results. Reaction of the Nb_2O_5 with the container material was apparently a factor. (K.S.W.)

53562 METHOD OF MAKING A NUCLEAR REACTOR FUEL ELEMET OF URANIUM MONONITRIDE IN A REFRACTORY METAL MATRIX. Kizer, Donald E.; Smith, Roy A.; Speidel, Edward O. (to United States Atomic Energy Commission). U. S. Patent 3,662,042. 9 May 1972. Filed 25 Sep 1970.

A high-temperature dimensionally stable nuclear reactor fuel element of uranium mononitride in a refractory metal matrix having evenly distributed porosity is prepared by cold pressing a mixture of a powdered refractory metal and powdered U_2N_3, forming a body which is then densified by heating under pressure to prevent complete decomposition of the U_2N_3. The densified body is then heated to decompose the U_2N_3 to UN, leaving evenly distributed porosity throughout the element. (Official Gazette)

53563 OXIDATION OF UO_2 FUEL PELLETS DURING HYDROGEN SINTERING. Bannister, M. J.; Buykx, W. J. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). J. Aust. Ceram. Soc.; 8: No. 2, 27-32(Aug 1972).

Surface cracking occurred in UO_2 fuel pellets sintered to high density in a hydrogen atmosphere pusher furnace with counter-current gas flow. The presence of a two-phase microstructure close to the surface of these pellets suggested that the cracking was caused by surface oxidation, resulting from the oxygen impurity in the inlet hydrogen. X-ray diffraction of the pellet surface after the removal of progressive layers confirmed that oxidation had occurred, as major amounts of one of the tetragonal U_3O_7 oxides were found close to the surface. Experiments were performed to establish whether surface oxidation could cause cracking, to determine the oxidation temperature required, and to discover whether oxygen could be retained in the sintering furnace to temperatures high enough to cause cracking. It was concluded that surface cracking was probably caused by surface oxidation above 900°C, the retention of oxygen in the gas stream at these temperatures being dependent on the geometry of the furnace, the flow rate of the gases and the catalytic activity of the internal furnace surfaces. (auth)

53564 EPITAXIAL GROWTH OF TANTALUM CARBIDE. Naiki, Toshio; Ninomiya, Masayuki; Ihara, Masayoshi (Kyoto Technical Univ.). Jap. J. Appl. Phys.; 11: No. 8, 1106-12(Aug 1972).

Films of tantalum carbide (TaC) known as a material with high melting point (3877°C) are formed on substrates by electron beam evaporation technique. The substrates are CaF_2, MgO, and NaCl single crystals cleaved in air. The range of substrate temperature is from 25°C to 1030°C. Pressures in the evaporation chamber are about 10^{-6} torr during the deposition. Rates of deposition are about 25 Å per second. Thicknesses of the deposits are less than 500 Å. These films were investigated by transmission electron diffraction and electron microscopy. Diffraction patterns of TaC films deposited on CaF_2 (111) and NaCl (100) surface are (111) and (100) spots with Debye-rings, respectively. Perfect epitaxial growth was observed for the TaC film deposited on the MgO (100) surface. The orientation relations were TaC(100)//MgO(100) and TaC[001]//MgO[011] at substrate temperatures above 390°C, and below this temperature Debye-rings were observed. (auth)

53565 HETEROGENEOUS NUCLEATION OF FISSION GAS BUBBLES AND GAS MIGRATION IN URANIUM DIOXIDE. Whapham, A. D. (Atomic Energy Research Establishment, Harwell, Eng.). Phil. Mag.; 26: No. 2, 399-407(Aug 1972).

The number and size of fission gas bubbles precipitated in irradiated uranium dioxide are calculated from a theory based on a balance between nucleation of bubbles at vacancy clusters produced by fission fragments and the agglomeration of bubbles by random motion. The distribution of bubble sizes is determined by gas atom capture, bubble agglomeration and irradiation resolution. Irradiation re-solution exceeds gas atom capture for large bubbles and causes the larger bubbles formed by agglomeration to shrink. The effect of the precipitated gas bubbles on gas-migration is considered, and it is shown that the bubble diffusion coefficient is likely to be larger than the trap-release diffusion coefficient. The predictions are compared with other theories of bubble nucleation, and with experimental observation. (auth)

53566 PROCEDURE FOR FABRICATION OF SPHERICAL OXIDIC FUEL AND BREEDER PARTICLES. Hackstein, Karl; Venet, Pierre; Pirk, Hans (to Brown, Boveri Krupp Reaktorbau GmbH. Kernforschungsanlage). German Patent 1,542,344. 18 Jun 1970. Filed 2 Apr 1966. (In German).

The procedure for fabrication of spheroid oxide fuel and breeder particles is characterized by a fine-milling process through which the surface properties of the oxide powder are changed in such a way that subsequently, without any additives, it can be granulated into spherical particles and, at higher temperatures, it can be sintered into dense particles. The fine-milling occurs in either air or steam beam mills (so-called micronizers or jetomizers). Preferably, milling is conducted to a grain-size smaller than 1 micron. The milling and granulation processes are conducted continuously. The granulate is continuously sintered to dense spherical particles at temperatures from 1600 to 1700°C. (H.B.G.)

53567 PREPARATION OF TRANSPARENT EuO FILMS BY OXIDATION OF Eu FILMS. Kawabe, Ushio; Tarutani, Yoshinobu; Kudo, Mitsuhiro (Hitachi, Ltd., Tokyo). Jap. J. Appl. Phys.; 11: No. 8, 1215(Aug 1972).

Films of EuO were prepared by oxidation of Eu films after vacuum deposition of bulk Eu, and effects of oxidizing and annealing temperatures upon the room temperature optical absorption band were studied. Oxidized films showed a characteristic x-ray diffraction pattern, which was identified essentially as that of bulk EuO with the NaCl-type structure. The lattice constants of the films were between 5.14 and 5.15 Å. The films were also unstable after oxidation. However, annealed films were stable even in air and colored blue. (P.C.H.)

53568 ANODE EROSION WITH ALLOYS OF CARBIDES OF TRANSITION METALS WITH IRON, COBALT, AND NICKEL. Samsonov, G. V.; Verkhoturov, A. D.; Petrova, E. M. Fiz. Khim. Obrab. Mater.; No. 1, 140-4(1972). (In Russian).

Carbides of group IV–V metals of the periodic system when alloyed with Fe, Co, and Ni showed sharply reduced erosion tendencies in comparison with pure carbides, and the transfer coefficient was raised from 6 or 7 to 70 to 80%. The carbides tested were chiefly TiC, ZrC, and HfC, and in the systems of metal-carbide investigated, the erosion resistance decreased in the order: MeC–Ni, MeC–Co, and MeC–Fe. (K.S.W.)

53569 MATERIALS REVIEW FOR '72. National SAMPE Symposium and Exhibition, Los Angeles, California, April 11–13, 1972. SAMPE Volume 17. Azusa, Calif.; Society of Aerospace Material and Process Engineers (1972). 312p. (CONF-720437).

Thirty-one articles are included; a separate abstract was prepared for each of seven. The remaining 24 articles contain information on: improved tap laying machine; effects of microstructural variations on K_{1c} in 2024-T851 plate; plywrapping—a low cost fabrication method for composite structures; fabrication of advanced composites; continuous filament reinforced thermoplastics; Type A graphite fiber—high performance—low cost; fabrication and properties of AVCO 3D C/C cylinder materials; development and evaluation of MOD 3 C/C composites; bulk effect of particulate fillers in epoxy resin compositions; NR-150 polyimide binders; addition-type polyimides from solutions of monomeric reactants; flexural strength of pyco-bond pan precursor carbon fiber substrates; C–C composite material; autoclavable resins; applications of polymer technology; novel low-cost thermoplastic material; orthopedic applications of biocarbon implants; emerging requirements for aerospace materials in transportation industry; aerospace materials technology in consumer appliances; graphite/epoxy composites; advanced organic fibers for L-1011 interior structures; and composite vane fabrication development for gas turbine application. (P.C.H.)

For abstracts of individual papers see: 53570–53575 and 53716.

53570 COCURING ADVANCED COMPOSITE MATERIALS. Casale, R. (Air Force Materials Lab., Wright Patterson AFB, Ohio); Stansbarger, D. L. pp IA.1.1-35 of Materials Review for '72. Azusa, Calif.; Society of Aerospace Material and Process Engineers (1972).

From seventeenth National SAMPE symposium and exhibit; Los Angeles, CA. (11 Apr 1972). See CONF-720437.

While the feasibility of cocuring operations has been shown, additional studies were required to demonstrate the validity and reproducibility of this technique, as well as show a reduction in the production cost of advanced composite structures, prior to implementation into a production atmosphere. The results of an Air Force funded study on the investigation and optimization of cocuring techniques for primary aircraft components are presented. Included are test data on the effects of dimpling on the physical and mechanical properties of both graphite and boron reinforced composite systems using various honeycomb cell sizes, laminate thicknesses, fiber orientations, and cure pressures. Test data are also presented on mechanical and dimensional properties of cocured graphite-to-graphite, graphite-to-boron, and boron-to-boron composite panels. Fabrication of boron and graphite cocured subscale assemblies to define shape limitation is presented and discussed. Primary graphite and boron component (horizontal stabilizer spar-splice and horizontal stabilizer root end assemblies) fabrication utilizing cocuring techniques are reviewed and discussed. Production cost analysis to demonstrate high cost centers and/or cost saving in tooling, manufacturing, and cure time by the utilization of cocuring operations in lieu of conventional manufacturing methods is presented with a projected view as to production cost for typical aircraft structures. (auth)

53571 CHEMICAL VAPOR DEPOSITION OF BORON ON A CARBON MONOFILAMENT SUBSTRATE. DeBolt, H. E. (Avco Corp., Lowell, Mass.); Krukonis, V. J.; Neff, R. M.; Wawner, F. E. pp IIB.2.1-10 of Materials Review for '72. Azusa, Calif.; Society of Aerospace Material and Process Engineers (1972).

From seventeenth National SAMPE symposium and exhibit; Los Angeles, CA. (11 Apr 1972). See CONF-720437.

A boron filament elongates as the boron layer is vapor deposited, and the elongation increases with increasing radius of boron, reaching about 2% for 2 mil radial growth. This elongation can exceed the ultimate strain of the carbon monofilament and can result in substrate fracture which simultaneously damages the boron layer. The mismatch in boron-substrate elongation limited for a long period the development of boron on carbon as a viable material. Deposition of a layer of pyrolytic graphite (PG) on the carbon monofilament before deposition of boron was found to eliminate fracture, and the damage to the boron was thereby avoided; the breakthrough in circumventing the boron-carbon strain mismatch placed carbon substrate in a potentially competitive position with boron on tungsten. Deposition of 4 mil boron on a 1.3 mil carbon monofilament yielded a product with a specific modulus higher than that of 4 mil boron on 0.5 mil tungsten by 4%. Tensile strength averages in the 400-500 Ksi range are common, and frequently tests at the 600 Ksi level are achieved, indicating that strengths at least as good as those obtained with boron-on-tungsten are realizable. The use of PG-coated carbon as a substrate results in higher production speeds and combined with a potential savings in substrate cost, there is expected to result an overall cost reduction of the boron filament product. (auth)

53572 BORON NITRIDE COATED BORON FIBERS. Camahort, Jose L. (Avco Corp., Lowell, Mass.). pp IIIB.2.1-7 of Materials Review for '72. Azusa, Calif.; Society of Aerospace Material and Process Engineers (1972).

From seventeenth National SAMPE symposium and exhibit; Los Angeles, CA. (11 Apr 1972). See CONF-720437.

A method for surface nitriding boron fibers is described. The process involves initially forming a liquid boron oxide coating on the fiber by heating the boron fiber at approximately 1300°F in air and then converting the liquid oxide coating to a solid, continuous boron nitride coating by heating the fiber at approximately 1875°F in an ammonia-nitrogen atmosphere. The resulting boron nitride coated boron fiber shows great potential as a reinforcement for metal matrix composites. (auth)

53573 APPLICATION OF ADVANCED METAL-MATRIX COMPOSITES TO AIRCRAFT STRUCTURES. Maikish, C. R.; Wennhold, W. F.; Weisinger, M. D. (General Dynamics, San Diego, Calif.). pp VA.2.1-4 of Materials Review for '72. Azusa, Calif.; Society of Aerospace Material and Process Engineers (1972).

From seventeenth National SAMPE symposium and exhibit; Los Angeles, CA. (11 Apr 1972). See CONF-720437.

A program was conducted to expand the range of usefulness of metal-matrix composite materials as applied to primary aircraft structure. Previous work with metal-matrix composites has shown the potential for significant weight savings and indicated

the need for improvements in several areas. The principal task accomplished during this program was the design, analysis, and fabrication of an aircraft bulkhead using boron/aluminum as the primary structural material. In support of the task, subcomponent test specimens were built and tested. Other supporting tasks included increasing the shear and transverse strength of the matrix by heat treatment, and the investigation of matrix materials other than aluminum. (auth)

53574 RESIN BONDED BORON–ALUMINUM COMPOSITES. Novak, R. C.; Pike, R. A.; Prewo, K. M.; Kreider, K. G. (United Aircraft Research Labs., East Hartford, Conn.). pp VA.5.1-6 of Materials Review for '72. Azusa, Calif.; Society of Aerospace Material and Process Engineers (1972).

From seventeenth National SAMPE symposium and exhibit; Los Angeles, CA. (11 Apr 1972). See CONF-720437.

A new composite material is described which combines the excellent properties of metal matrix composites with the ease of fabrication of resin composites. The material consists of thin preconsolidated monolayer tapes of boron-aluminum which are coated with a resin adhesive, then bonded together. The process for fabricating the monolayer tape is discussed along with techniques for cleaning and coating it with resin. Composites have been prepared using several resins as adhesives. The techniques used to fabricate these composites are described, and the results of mechanical tests on several of the materials are presented. (auth)

53575 BLADE DEVELOPMENT IN THE ADVANCED COMPOSITE ENGINE (ACE) PROGRAM. Stargardter, Hans (Pratt and Whitney Aircraft, East Hartford, Conn.). pp VB.5.1-13 of Materials Review for '72. Azusa, Calif.; Society of Aerospace Material and Process Engineers (1972).

From seventeenth National SAMPE symposium and exhibit; Los Angeles, CA. (11 Apr 1972). See CONF-720437.

Composite fan blades were developed for high temperature applications under the Advanced Composite Engine (ACE) Contract. Stage One blades were made of boron-polyimide for 500°F and Stage Three blades were made of BORSIC-aluminum for 600°F. (auth)

53576 EFFECT OF COMMINUTION ON THE SINTERABILITY OF ALUMINA AND TUNGSTEN CARBIDE POWDERS. Pryde, R. B. (Univ. of Surrey, Eng.); Sarkar, B. K.; Towner, J. M.; Waldron, M. B. pp 4.1-8 of Proceedings of the 7th Plansee Seminar on Powder Metallurgy of High Temperature Materials. Vol. I. /Benesvosky, F. (ed.). Reutte/Tyrol, Austria; Metallwerk Plansee (1971).

From seventh Plansee seminar on powder metallurgy of high temperature materials; Reutte/Tyrol, Austria (21 Jun 1971). See CONF-710602-(Vol.1).

The effects of ball milling and ball milling and annealing on the microstrains, crystallite size, and particle size in alumina and tungsten carbide were measured using x-rays, electron microscopy, and BET measurements. The effects of contamination were also evaluated. Thus, tungsten carbide gave very different sintering characteristics when milled in air and in argon; these differences were attributed to the oxygen absorbed during milling reacting to give gaseous carbon monoxide and W_2C at the sintering temperature. Milling was found to improve the sinterability of alumina as measured by densification and of tungsten carbide as measured by cold crushing strength. This improved sinterability was found to be due to the microstrain introduced into the powders during milling, the improvement occurring at temperatures where the majority of the strain was being removed. (auth)

53577 GROWTH AND HARDNESS OF SPHERICAL AGGLOMERATES FROM POWDERS OF HIGH MELTING POINT MATERIALS. Claussen, N.; Petzow, G. (Max-Planck Institut fuer Metallforschung, Stuttgart). pp 6.1-14 of Proceedings of the 7th Plansee Seminar on Powder Metallurgy of High Temperature Materials. Vol. I. /Benesvosky, F. (ed.). Reutte/Tyrol, Austria; Metallwerk Plansee (1971). (In German).

From seventh Plansee seminar on powder metallurgy of high temperature materials; Reutte/Tyrol, Austria (21 Jun 1971). See CONF-710602-(Vol.1).

A procedure is described for the production of spheres from powders in a wobbling rotating container. Preconditions for growth of the spheres are appropriate germinal agglomerates and a certain particle size depending on the binding additive. Growth proceeds in four distinct steps which are influenced by various process parameters. The most important parameters are angle of inclination of the container, humidity of air, rate of rotation, and amount of material. An angle of 40° yields best mixing and narrowest spectrum of diameters. High humidity leads to rapid growth and great firmness. Several hitherto unknown effects are discussed, such as diameter, distribution, and tetraeder formation during agglomeration. The procedure was tested on various oxides such as Al_2O_3, MoO_3, and WO_3 as well as on WC, alloys, and tungsten metal powders. Results are discussed with respect to technical application. (H.B.G.)

53578 HOT ISOSTATIC PRESSING: A NEW METHOD FOR PRODUCTION OF HARD METALS AND ALLOY STEELS. Johansson, Rune (ASEA, Vaesteras, Sweden). pp 8.1-12 of Proceedings of the 7th Plansee Seminar on Powder Metallurgy of High Temperature Materials. Vol. I. /Benesvosky, F. (ed.). Reutte/Tyrol, Austria; Metallwerk Plansee (1971). (In German).

From seventh Plansee seminar on powder metallurgy of high temperature materials; Reutte/Tyrol, Austria (21 Jun 1971). See CONF-710602-(Vol.1).

Hot isostatic pressing is now, after many years of research, ready for production as processes are developed and hot isostatic production presses for high pressure and high temperature and with large dimensions and short cycle-times are available. The manufacture of tungsten carbides and high-speed tool steels by means of hot isostatic pressing are described. Tungsten carbide is a dense material but there remains, nevertheless, always a number of pinholes that influence the tensile strength of the material to a high degree. A reduction of the pinhole volume of 10^2 to 10^3 times has been measured. The conventional-made high-speed tool steel shows a very great tendency to segregations and irregular coarse-grained structure. By manufacturing high-speed tool steel out of powder, a material with a very fine structure is achieved. The carbide grain size is very small. Further segregations in the material are eliminated. Increase in life of 390% has been observed with drills made by hot isostatic pressed high-speed tool steel. (auth)

53579 INFLUENCE OF NICKEL ADDITION ON THE REDUCTION OF WO_3 WITH HYDROGEN AND ON THE SINTERING OF THE THUS PRODUCED TUNGSTEN POWDERS. Lambiev, D. K.; Gospodinov, G. A.; Pangarova, B. H. (NITI-Metal Ceramics, Sofia. Higher Inst. of Chemical Tech., Sofia). pp 15.1-19 of Proceedings of the 7th Plansee Seminar on Powder Metallurgy of High Temperature Materials. Vol. I. /Benesvosky, F. (ed.). Reutte/Tyrol, Austria; Metallwerk Plansee (1971). (In French).

From seventh Plansee seminar on powder metallurgy of high temperature materials; Reutte/Tyrol, Austria (21 Jun 1971). See CONF-710602-(Vol.1).

Studies were made on the effects of nickel additions from 0.06 to 4% and of reduction temperatures from 750 to 1050°C on the physical properties of produced tungsten powders. The addition of nickel led to larger surface and smaller size of the mosaic blocks. Increased reduction temperature had the opposite effect. Sintering of these powders was examined at 1300°C. The sintered bodies had improved physicomechanical properties in comparison to pure tungsten powder. (H.B.G.)

53580 EQUILIBRIA AND KINETICS OF DEGASSING IN THE SYSTEMS Mo–N, W–N, AND Re–N. Fromm, E.; Jehn, H. (Max-Planck-Institut fuer Metallforschung, Stuttgart). pp 26.1-15 of Proceedings of the 7th Plansee Seminar on Powder Metallurgy of High Temperature Materials. Vol. I. /Benesvosky, F. (ed.). Reutte/Tyrol, Austria; Metallwerk Plansee (1971). (In German).

From seventh Plansee seminar on powder metallurgy of high temperature materials; Reutte/Tyrol, Austria (21 Jun 1971). See CONF-710602-(Vol.1).

The nitrogen solubility was determined in the systems Mo–N, W–N, and Re–N as a function of pressure and temperature (15 to 600 torr N_2, 1600 to 3000°C). In all three systems the solubility was very low (0.5 to 100 ppM N) and decreased in the order molybdenum, tungsten, rhenium. With increasing temperature the isobaric solubility rose and Sieverts law was obeyed. Thermodynamic data of the solution of nitrogen in these metals were calculated and the terminal solubility of nitrogen in molybdenum has been estimated. Furthermore, the kinetics of the degassing of nitrogen containing molybdenum and tungsten was investigated. In the first period of the degassing process the rate was determined by the transition of nitrogen from the solute into the adsorbed state. After longer annealing periods, the nitrogen diffusion in the metal became the rate determining step and the rate constants could be used for the evaluation of the diffusion coefficient of nitrogen in molybdenum, tungsten, and rhenium (1200 to 2200°C). In order to demonstrate the difference between the nitrogen systems of group Va and group VIa metals, the results of these investigations were compared with corresponding data for the other refractory metals, vanadium, tantalum, niobium, and chromium. (auth)

53581 NASA RESEARCH ON REFRACTORY COMPOUNDS. Gangler, James J. (National Aeronautics and Space Administration, Washington, D. C.). pp 48.1-36 of Proceedings of the 7th Plansee Seminar on Powder Metallurgy of High Temperature Materials. Vol. II.. /Benesvosky, F. (ed.). Reutte/Tyrol, Austria; Metallwerk Plansee (1971).

From seventh Plansee seminar on powder metallurgy of high temperature materials; Reutte/Tyrol, Austria (21 Jun 1971). See CONF-710602-(Vol.2).

The behavior and properties of the refractory carbides, nitrides, and borides are being investigated by NASA as part of its research aimed at developing superior heat resistant materials for aerospace applications. Fundamental studies are being conducted on the electronic and defect structures of the carbides. The results indicate that there is promise for improving the strength and ductility of these materials. The nature of the bonding in carbides and nitrides is also being studied by determining their vaporization and decomposition characteristics. Studies of the zirconium–carbon–oxygen system showed that zirconium oxycarbides of different compositions and lattice parameters can be formed between 1500 and 1900°C and are stable below 1500°C. More applied studies showed that hot working generally improves the microstructure and therefore the strength of TiC and NbC. Sintering studies on UN indicated that very high densities can be achieved. Hot pressing of cermets of HfN and HfC produced good mechanical properties for high temperature bearing applications. Attempts to improve the impact resistance of boride composites by the addition of a nickel or carbon yarn were not overly successful. The present technology of the refractory compounds suggests that they will be used in aerospace applications in the near future. (auth)

53582 STUDY OF THE OBTAINING CONDITIONS AND THERMOEMISSION CHARACTERISTICS OF BORIDES OF THE RARE-EARTH METALS. Meerson, G. A.; Manelis, R. M.; Nurmukhamedov, V. Kh.; Mamedov, F. G. pp 52.1-15 of Proceedings of the 7th Plansee Seminar on Powder Metallurgy of High Temperature Materials. Vol. II. /Benesvosky, F. (ed.). Reutte/Tyrol, Austria; Metallwerk Plansee (1971).

From seventh Plansee seminar on powder metallurgy of high temperature materials; Reutte/Tyrol, Austria (21 Jun 1971). See CONF-710602-(Vol.2).

Studies were made on conditions for preparing La, Y, and Gd borides and their emissive and physical properties. The results showed that borides of stoichiometric composition can be obtained by the vacuum-thermic reduction of oxides with boron at 5% boron excess in the initial charge, in order to compensate for volatilization, and at a definite optimal porosity (53 to 55%) of the initial briquettes. It was found that the electron emission properties of the borides improved as the boron: metal ratio decreased. LaB_4 had the best emission properties. Conditions for obtaining and sintering double borides, $La(Ba)B_6$, as well as their properties were also studied. It was proved that up to 40 molecular percent solid solutions of LaB_6–BaB_6 retained the metallic character of conductivity, had a smaller electron work function, and higher density of emission current than LaB_6. (P.C.H.)

53583 SILICON DIFFUSION IN THE Me_5Si_3 PHASES OF THE METALS NIOBIUM, TANTALUM, MOLYBDENUM, AND TUNGSTEN. Fitzer, E.; Schmidt, F. K. (Univ., Karlsruhe, Ger.). pp 53.1-14 of Proceedings of the 7th Plansee Seminar on Powder Metallurgy of High Temperature Materials. Vol. II. /Benesvosky, F. (ed,). Reutte/Tyrol, Austria; Metallwerk Plansee (1971). (In German).

From seventh Plansee seminar on powder metallurgy of high temperature materials; Reutte/Tyrol, Austria (21 Jun 1971). See CONF-710602-(Vol.2).

Technical significance of the Me_5Si_3 phase formation, silicon transport in the Me_5Si_3 phases of various high-melting metals, calculation of diffusion coefficients for silicon diffusion in the Mo_5Si_3 and Nb_5Si_3 phases, and other influences on the growth rate of Me_5Si_3 phases are discussed. Among the four metals studied, a distinct difference in the rate of silicon transport prevailed. Silicon transport in the Mo_5Si_3 phase surpassed that in the other metals. The Ta_5Si_3 phase showed the lowest rate of silicon transport. Transport rates in Nb_5Si_3 and W_5Si_3 were similar and crossed each other in the temperature range of 1200°C. (H.B.G.)

53584 PROCEEDINGS OF 7th PLANSEE SEMINAR ON POWDER METALLURGY OF HIGH TEMPERATURE MATERIALS, REUTTE/TYROL, AUSTRIA, JUNE 21–25, 1971. VOLUME III. Benesvosky, F. (ed.). Reutte/Tyrol, Austria; Metallwerk Plansee (1971). 167p. (In several languages). (CONF-710602-(Vol.3)).

Seven articles are included: separate abstracts were prepared for six. The remaining article on vacuum atomization was not in scope for NSA. (P.C.H.)

For abstracts of individual papers see: 53585–53589 and 53678.

53585 OXIDATION BEHAVIOR OF Mo + ZrO_2 CERMETS. Heitzinger, F. (Metallwerk Plansee AG, Reutte, France). pp 1-8 of Proceedings of the 7th Plansee Seminar on Powder Metallurgy of High Temperature Materials. Vol. III. /Benesvosky, F. (ed.). Reutte/Tyrol, Austria; Metallwerk Plansee (1971). (In German).

From 7th Plansee seminar on powder metallurgy of high temperature materials; Reutte/Tyrol, Austria (21 Jun 1971). See CONF-710602-(Vol.3).

Below the MoO_3 melting point, zirconium oxide addition significantly increased the oxidation rate of molybdenum. Above the MoO_3 melting point, the total oxidation characteristics of molybdenum were changed and the linear oxidation course was altered to a parabolic ΔG-time relationship. Only in the range from 1100 to 1200°C, the so-called range of catastrophic oxidation, the linear oxidation course of molybdenum recurred. Nevertheless, the oxidation rate was about 10 times lower than that of pure molybdenum in the same temperature range. The oxidation behavior of Mo + ZrO_2-cermets can be expressed in the simplified statement that below the MoO_3 melting point, oxidation rate of molybdenum is significantly enhanced through addition of ZrO_2 while, above the MoO_3 melting point, it is significantly decreased through ZrO_2 addition. (tr-auth)

53586 PRODUCTION OF FORMED BODIES FROM HIGH-MELTING COMPOUNDS ACCORDING TO THE CASTING PROCEDURE FOR THERMOPLASTIC MASSES. Samsonov, G. V.; Slepzov, V. M.; Trunov, G. V. (Inst. of Problems in Material Studies, Kiev). pp 12.1-13 of Proceedings of the 7th Plansee Seminar on Powder Metallurgy of High Temperature Materials. Vol. III. /Benesvosky, F. (ed.). Reutte/Tyrol, Austria; Metallwerk Plansee (1971). (In German).

From 7th Plansee seminar on powder metallurgy of high temperature materials; Reutte/Tyrol, Austria (21 Jun 1971). See CONF-710602-(Vol.3).

Principal feasibility was demonstrated for the casting of thermoplastic masses to form products from high-melting compounds and hard materials. The influence of shape and grain of powder particles was studied with respect to viscosity as well as to optimal ratio of liquid to solid phases. Advantages of using spherical powders were demonstrated. It was found that, to obtain high density casting products, the use of polydispersed powders containing 40 to 50% gross grains was necessary. Removal of the liquid phase and sintering of the raw product were examined. It was demonstrated that the procedure yields products of high quality with perfect configuration, independent of their complexity. (tr-auth)

53587 ACTIVATION MECHANISM OF SINTERING. Accary, A. (Univ., Clermont-Ferrand, France). pp 14.1-16 of Proceedings of the 7th Plansee Seminar on Powder Metallurgy of High Temperature Materials. Vol. III. /Benesvosky, F. (ed.). Reutte/Tyrol, Austria; Metallwerk Plansee (1971). (In French).

From 7th Plansee seminar on powder metallurgy of high temperature materials; Reutte/Tyrol, Austria (21 Jun 1971). See CONF-710602-(Vol.3).

The relative meaning of activated sintering is defined, and examples of such processes involving activation either by chemical means or physical ones are reviewed. The most probable mechanisms are discussed and classified into three main groups: increase of the diffusion velocity; improvement of the morphology of the compact before and during sintering; and annihilation of negative activation factors that might impair the sinterability of the powder used. (P.C.H.)

53588 THERMODYNAMICS OF LIQUID SOLUTIONS Mo–O AND Mo–C. Kozina, L. N.; Revyakin, A. V.; Samarin, A. M. (Inst. of Metallurgy, Moscow). pp 32.1-20 of Proceedings of the 7th Plansee Seminar on Powder Metallurgy of High Temperature Materials. Vol. III. /Benesvosky, F. (ed.). Reutte/Tyrol, Austria; Metallwerk Plansee (1971).

From 7th Plansee seminar on powder metallurgy of high temperature materials; Reutte/Tyrol, Austria (21 Jun 1971). See CONF-710602-(Vol.3).

A thermodynamic analysis was made of the deoxidation of molten Mo. Methods are described for calculating the oxygen concentration in the metal. Mass transfer processes were examined for determining the oxygen concentration in the gas phase at the metal surface. The reaction between Mo and CO was investigated by the same method. The determination of the thermodynamic functions of the solution of oxygen in molten Mo made it possible to carry out certain thermodynamic calculations connected with the removal of oxygen from Mo during vacuum fusion. The results showed that oxygen is removed from a binary solution mainly in the atomic state. (P.C.H.)

53589 EFFECTS OF ALLOYING ON STRUCTURAL STABILITY AND COHESION BETWEEN PHASES IN METAL–OXIDE COMPOSITES. Navara, Erik; Easterling, Kenneth; Fischmeister, Hellmut (Chalmers Univ. of Tech., Goteborg). pp 43.1-13 of Proceedings of the 7th Plansee Seminar on Powder Metallurgy of High Temperature Materials. Vol. III. /Benesvosky, F. (ed.). Reutte/Tyrol, Austria; Metallwerk Plansee (1971).

From 7th Plansee seminar on powder metallurgy of high temperature materials; Reutte/Tyrol, Austria (21 Jun 1971). See CONF-710602-(Vol.3).

Studies were made on the cohesion between the matrix and the strengthening phase of a composite, and also the effects of structural stability on the strengthening mechanism. The main concern was the effect of minor alloying additions on particle stability and particle-matrix cohesion. The matrices studied were Ni, Fe, and Fe-40 Ni, each with various minor alloying additions. The results showed that contact angle measurements probably allow a more precise assessment of the work of adhesion than mechanical measurements of the type used. Solute additions to the matrix had a great effect on structural stability, i.e., on the resistance to particle coarsening. Detrimental effects arose when the solute, in partitioning to the oxide, reduced the thermodynamic stability of the particle phase (Al_2O_3). However, improvements in service life by a factor of 1.6 in austenitic Fe-base alloys, and by a factor of 3.4 in Ni-based alloys were indicated by the best observed rate constants in the materials studied. It was concluded that it is possible to improve the ductility of particle strengthened materials considerably by suitable interface-active solutes. (P.C.H.)

53590 POWDER METALLURGY OF HIGH-TEMPERATURE MATERIALS. Kieffer, R. (Technische Hochschule, Vienna). pp 1.1-16 of Proceedings of the 7th Plansee Seminar on Powder Metallurgy of High Temperature Materials. Vol. IV. /Benesvosky, F. (ed.). Reutte/Tyrol, Austria; Metallwerk Plansee (1971). (In German).

From 7th Plansee seminar on powder metallurgy of high temperature materials; Reutte/Tyrol, Austria (21 Jun 1971). See CONF-710602-(Vol.4).

A survey of the powder metallurgy for heat-resistant materials is presented. Melting points and combination possibilities for various groups of raw materials are discussed. Next the progress from iron through platinum and osmium to tungsten is reviewed. A section is devoted to the utilization of heat-resistant materials and powder metals in the space program. Also discussed is the application of sintered high-temperature material to tools, ovens, and plasma nozzles. Studies performed by the Vienna research circle comprise HfC-containing heat-resistant metals; the carbidothermal production of high-melting alloys; development of high-temperature-high-pressure autoclaves and study of nitrogen-containing systems; coating of hard metals with nitrides and carbonitrides; hard metals with carbonitride bases; sintered tool steels; the new hectoboride (M_1B_{70}-100); and cermets. (44 references). (H.B.G.)

53591 COLDSTREAM PROCESS. Walraedt, Jean; Mathy, Pierre (Floridienne, SA, Brussels). pp 2.1-12 of Proceedings of the 7th Plansee Seminar on Powder Metallurgy of High Temperature Materials. Vol. IV. /Benesvosky, F. (ed.). Reutte/Tyrol, Austria; Metallwerk Plansee (1971).

From 7th Plansee seminar on powder metallurgy of high temperature materials; Reutte/Tyrol, Austria (21 Jun 1971). See CONF-710602-(Vol.4).

The production of powders in the Coldstream process is based on impacting the particles at high velocities against a fixed target. The raw material is fed into the blast generator and pressurized to the desired blasting pressure. From there it is metered, mainly by gravity, into the main air stream. It is accelerated through a venturi towards the blast chamber. The materials hit and break against the target in the blast chamber. At the same time, cooling takes place through adiabatic air expansion. Advantages of the process are listed, and the results of reprocessing sintered tungsten carbide scrap into powder are described. (P.C.H.)

53592 TECHNOLOGY OF CERMETS. Nazare, S.; Ondracek, G.; Thuemmler, F. (Institut fuer Material- und Festkoerperforschung, Karlsruhe, Ger.). pp 44.1-32 of Proceedings of the 7th Plansee Seminar on Powder Metallurgy of High Temperature Materials. Vol. IV. /Benesvosky, F. (ed.). Reutte/Tyrol, Austria; Metallwerk Plansee (1971). (In German).

From 7th Plansee seminar on powder metallurgy of high temperature materials; Reutte/Tyrol, Austria (21 Jun 1971). See CONF-710602-(Vol.4).

The literature on cermets is reviewed. Powder characteristics, combinations, compaction, pressing, sintering, and fabrication are discussed. As a special example, the technology of plate-shaped fuel elements for nuclear reactors is outlined. A flow scheme is given for the production of plate-shaped fuel elements and for the pressing of rod-shaped dispersion fuel elements. 88 references are included. (H.B.G.)

53593 INFLUENCE OF ELECTRON CONFIGURATION ON THE ABSORPTION BEHAVIOR OF MIXED CRYSTALS OF HARD MATERIALS. Goretzki, H.; Scheuermann, W. (Max-Planck Institut fuer Metallforschung, Stuttgart). pp 50.1-13 of Proceedings of the 7th Plansee Seminar on Powder Metallurgy of High Temperature Materials. Vol. IV. /Benesvosky, F. (ed.). Reutte/Tyrol, Austria; Metallwerk Plansee (1971). (In German).

From 7th Plansee seminar on powder metallurgy of high temperature materials; Reutte/Tyrol, Austria (21 Jun 1971). See CONF-710602-(Vol.4).

Absorption studies on carbides, nitrides, and oxides of the 4a and 5a transition metals showed that the non-metallic component exerts a significant influence on absorption. Carbides and nitrides showed the greatest difference in energetic conditions of their surface layers. Carbides showed an unequivocal relationship between concentration of free charges and adhesion energy. Without exception, nitrides poorly absorbed molten metals. Complete absorption of the binding phase on carbides required high charge concentrations in the lattice. The unfavorable absorption properties of the 4a metal carbides can be improved through mixed crystal formation with carbides of the 5th and 6th subgroups. It is advisable to produce only a thin surface layer with high charge concentration. This principle is largely used in hard metals on the TiC basis with admixtures to the binding phase. (H.B.G.)

53594 ADDITION EFFECTS OF SILICIDES OF SEVERAL TRANSITION METALS BELONGING TO GROUPS IV THROUGH VI ON THE SINTERING AND OXIDATION RESISTANCE AT HIGH TEMPERATURE OF DIBORIDES OF TITANIUM AND ZIRCONIUM. Pastor, H.; Meyer, R. (Ugine-Carbone, Grenoble, France). pp 51.1-19 of Proceedings of the 7th Plansee Seminar on Powder Metallurgy of High Temperature Materials. Vol. IV. /Benesvosky, F. (ed.). Reutte/Tyrol, Austria; Metallwerk Plansee (1971). (In French).

From 7th Plansee seminar on powder metallurgy of high temperature materials; Reutte/Tyrol, Austria (21 Jun 1971). See CONF-710602-(Vol.4).

Experiments on 18 pseudo-binary systems $(Ti,Zr)B_2$-M_xSi_y showed the difficulties and the complexity of sintering these compounds. From a structural standpoint, the couple boron-silicon displayed more or less pronounced interactions, especially the formation of a solid solution $(Ti,Zr)B_2$-MSi_x with a cubic phase (Ti,Zr)B which probably was ternary. Certain combinations of the systems TiB_2-TiSi_2, $TiB_2-Ti_5Si_3$, ZrB_2-ZrSi_2, $ZrB_2-Zr_5Si_3$, ZrB_2-MoSi_2, and especially TiB_2-CrSi_2, as well as ZrB_2-CrSi_2 were particularly interesting because of their sintering tendency, their micrographic picture, and their high resistance to heat oxidation. (H.B.G.)

53595 NONISOTHERMAL TECHNIQUES FOR STUDYING INITIAL-STAGE SINTERING. Woolfrey, J. L.; Bannister, M. J. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). J. Amer. Ceram. Soc.; 55: No. 8, 390-4(Aug 1972).

Nonisothermal techniques for analyzing initial-stage sintering are reviewed. It is shown that in principle they permit the determination of all the sintering parameters (rate law, activation energy, and diffusion coefficients) normally obtained from isothermal experiments. Comparison with results from isothermal experiments performed on the same materials (UO_2 and ThO_2 gel) demonstrates the validity and accuracy of the nonisothermal techniques. (auth)

53596 POLYMORPHIC MODIFICATIONS OF Pm_2O_3. Chikalla, T. D.; McNeilly, C. E.; Roberts, F. P. J. Amer. Ceram. Soc.; 55: No. 8, 428-9(Aug 1972).

Basic physical and chemical properties of Pm_2O_3 are tabulated and described. Discussions and data are included on cubic → monoclinic transformations, phase transformation temperatures, and melting point. (J.R.D.)

53597 EFFECT OF GREEN DENSITY ON THE INITIAL-STAGE SINTERING KINETICS OF UO_2. Woolfrey, J. L. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). J. Amer. Ceram. Soc.; 55: No. 8, 383-9(Aug 1972).

The kinetics of the initial-stage sintering of a UO_2 powder in H_2 were investigated over the range 600 to 1200°C by dilatometry. Decreasing green density below ≈40% of theoretical leads to progressively reduced rates of sintering. Initiation of the effect is related to a critical value of the ratio of pore size to particle size at which pores become stabilized and inhibit local shrinkage. Green density did not affect the sintering law or the apparent activation energy for sintering. A constant apparent activation energy for sintering of 86 ± 8 kcal/mol was found, indicating that diffusion of the same species is rate-controlling over this temperature range. Above 900°C, the rate-controlling mechanism is consistent with grain-boundary diffusion of the uranium ions. (auth)

53598 DIFFUSION IN THE SYSTEM K_2O–SrO–SiO_2. IV. MOBILITY MODEL, ELECTROSTATIC EFFECTS, AND MULTICOMPONENT DIFFUSION. Varshneya, A. K.; Cooper, A. R. (Case Western Reserve Univ., Cleveland). J. Amer. Ceram. Soc.; 55: No. 8, 418-21(Aug 1972).

Experimentally determined coefficients to describe multicomponent diffusion in the system K_2O–SrO–SiO_2 are compared with predictions of a simple model assuming ideal solution behavior. The agreement is satisfactory overall. On the basis of this model, it is suggested that the differences in mobilities of various ions cause deviations from the condition $\Sigma Z_i j_i = 0$ (Z = valence, j = flux) of no space-charge buildup. Although these deviations are small, e.g., after diffusion for 1 s, (charge flux)/(ionic flux) $\leq 10^{-7}$, the electric field caused by this deviation from electrical neutrality influences the diffusion kinetics markedly. (auth)

53599 TECHNIQUE FOR THE VISUALIZATION OF HEAVY METALS IN FUEL ELEMENTS FOR HIGH TEMPEATURE REACTORS. Leischner, E. (NUKEM GmbH, Wolfgang, Ger.); Stockhausen, J. Kerntechnik; 14: No. 7, 316-17(Jul 1972). (In German and English).

A roentgenographic technique, well known in medical diagnostic practice, which offers the possibility of demonstrating nondestructively the fuel distribution in fuel elements for high-temperature reactors is described. (auth)

Metals and Alloys

Refer also to abstracts 53584 and 53729.

53600 (WASH-1181-72) METALLURGY AND MATERIALS PROGRAMS, FISCAL YEAR 1972. (Division of Physical Research (AEC), Washington, D. C.). Jul 1972. 86p. Dep. NTIS.

A compilation and index of USAEC's programs is presented as an aid to research coordination and in selection of new programs. Information is included in sections on projects at laboratories and universities, funding levels, and an index. (P.C.H.)

53601 PROCEEDINGS OF 7th PLANSEE SEMINAR ON POWDER METALLURGY OF HIGH TEMPERATURE MATERIALS, REUTTE/TYROL, AUSTRIA, JUNE 21–25, 1971. VOLUME I. Benesvosky, F. (ed.). Reutte/Tyrol, Austria; Metallwerk Plansee (1971). 214p. (In several languages). (CONF-710602-(Vol.1)).

Nineteen articles are included; separate abstracts were prepared for 18. One article on internal nitriding of Mo–Hf alloys was previously included in NSA as 25: 40020. (P.C.H.)

For abstracts of individual papers see: 53576–53580, 53613, 53617–53624, and 53670–53673.

53602 PROCEEDINGS OF 7th PLANSEE SEMINAR ON POWDER METALLURGY OF HIGH TEMPERATURE MATERIALS, REUTTE/TYROL, AUSTRIA, JUNE 21–25, 1971. VOLUME II. Benesvosky, F. (ed.). Reutte/Tyrol, Austria; Metallwerk Plansee (1971). 197p. (In several languages). (CONF-710602-(Vol.2)).

Sixteen articles are included; separate abstracts were prepared for 12. The remaining four articles contain information on: microstructural studies of a synthetic material prepared by powder metallurgy; effects of small Mg additions on high-temperature properties of Ni–2.5 vol% Al_2O_3; studies on silicide systems using differential thermal analysis; and synthesis of refractory compounds of transition metals by molten metal dissolution. (P.C.H.)

For abstracts of individual papers see: 53581–53583, 53625–53629, and 53674–53677.

53603 PROCEEDINGS OF 7th PLANSEE SEMINAR ON POWDER METALLURGY OF HIGH TEMPERATURE MATERIALS, REUTTE/TYROL, AUSTRIA, JUNE 21–25, 1971. VOLUME IV. Benesvosky, F. (ed.). Reutte/Tyrol, Austria; Metallwerk Plansee (1971). 326p. (In several languages). (CONF-710602-(Vol.4)).

Eighteen articles are included; separate abstracts were prepared for 14. The remaining four articles contain information on: powder metallurgy versus melting and casting of high temperature alloys, tool steels, and specialty alloys; processing of stellites to fully dense forms; creep properties of dispersion strengthened Ag–Ga oxide alloys; and pressure sintering of refractory metal germanides. (P.C.H.)

For abstracts of individual papers see: 53590–53594, 53630–53632, and 53679–53684.

Corrosion and Erosion

Refer also to abstracts 52895, 53121, 55165–55169, 55172, and 55173.

53604 (BNWL-CC-449) CORROSIVITY OF THORIA DISSOLVENT SOLUTIONS. Maness, Roy F. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). 18 Jan 1966. Contract AT(45-1)-1830. 10p. Dep. NTIS.

The dissolution of thoria requires a fluoride-catalyzed nitric acid solution which is quite corrosive to most materials of construction. Aluminum nitrate is usually added to the dissolvent to reduce the hydrofluoric acid activity and thus the corrosivity of the system. As dissolution of thoria proceeds, Th(IV) forms a complex with fluoride ion which further reduces the corrosivity of the system. Corrosion tests of 304L stainless steel, Corronel 230, and HAPO-20 alloy were made in proposed thoria dissolvent solutions. The primary variables were nitric and hydrofluoric acid concentration, the presence of oxidants in the dissolvent and the metallurgical condition of the test specimens. Observed corrosion rates are presented. (auth)

53605 (DP-Report-522) BASIC STUDIES ON THE GROWTH OF CARBON DEPOSITION FROM CARBON MONOXIDE ON A METAL CATALYST. Project DRAGON. Third Annual Report, March 1, 1966–February 28, 1967. Warzee, M. (Atomic Energy Establishment, Winfrith (England)). Mar 1968. 82p. (THTR-56). Dep. NTIS (U. S. Sales Only).

The behavior of commercial steels in reactor coolant gases was studied. It was found that at 550°C, no protective layers were formed on mild steels nor on low alloy steels, whatever the superficial structure of the steel and the composition of the reactant gas mixture. Ferritic steels with chromium concentration above 8% were covered with partially or fully protective oxides, under the experimental conditions. A full protection under all experimental conditions has been achieved with a 12% Cr annealed ferritic steel. AISI 304 austenitic steel was covered by a protective oxide layer only after having been superficially strained. In the annealed state, the formed oxide was not protective and showed the same characteristics as that formed at 600°C, under the same conditions. At 600°C, austenitic alloys AISI 304, 321, 316 and Incoloy 800 became covered by a protective oxide layer after preliminary superficial straining. In the annealed state, such films appeared only on Incoloy 800 and then only if the gas mixture was not very oxidizing: 500 μ atm H_2, 500 μ atm CO, 5 μ atm H_2O, and 5 μ atm CO. This alloy subjected to mixture no. 1 (500 μ atm H_2, 500 μ atm CO, 50 μ atm H_2O, 50 μ atm CO_2) and still more the three other austenitic alloys, exposed to the two types of mixtures were involved in complex oxidation phenomena leading to the formation of unprotective layers and to a heterogeneity of the alloy at the grain boundaries. It could be shown that the condition, necessary and sufficient to ensure that the formed oxides were protective, is that the selective oxidation of Cr and Mn occurs outside the alloy. This implies that the diffusion rates of Cr and Mn in the alloy were far above the penetration rate of the anions into the alloy. If this condition is not met, internal selective oxidation of the elements constituting the alloy occurs, giving rise to partially oxidized and nonprotective superficial zones. The problem of the choice of the alloy convenient to heat exchangers must not be considered only from the point of view of the carbon deposit. The outlined results showed that compatibility of the chosen steel with the gas phase must also be examined taking corrosion resistance into account. It appears that the content of impurities in helium of a high temperature reactor is such that the gas mixture will be oxidizing. Under such circumstances, it appears that carbon deposition is unlikely but some difficulties might be encountered with respect to corrosion resistance of some types of materials. The heterogeneities at the grains boundaries, observed with austenitic steels undergoing internal selective oxidation are likely to alter the behavior, under stress, of the material. Long duration tests in gas mixtures corresponding to the probable composition in the reactor would be necessary in order to investigate the penetration rate, of internal oxidation zones. These tests should be carried out under stress conditions in order to investigate the risks of intergranular cracks. (auth)

53606 (MLM-1355) HYDROGEN IN STEEL. Chaney, K. F. (Mound Lab., Miamisburg, Ohio). 1 Jun 1966. Contract AT-33-1-Gen-53. 18p. Dep. NTIS.

Declassified 22 Oct 1971.

A survey of the literature was made to determine the effect of hydrogen in steel. The mechanism by which the hydrogen is introduced into the steel, the permeation of hydrogen in steel, and the various deleterious effects that it may have are discussed. (auth)

53607 (RFP-1891) CORROSION AND STRESS-CORROSION CRACKING OF PAINTED U-4.2 WT. PERCENT Nb. Macki, James M.; Kochen, Robert L. (Dow Chemical Co., Denver, Colo. Rocky Flats Div.). 7 Aug 1972. Contract AT(29-1)-1106. 11p. Dep. NTIS.

Salt spray (fog) and stress-corrosion cracking (SCC) tests were

conducted on painted U-4.2 wt % Nb alloy specimens. The paint coating consisted of an epoxy primer with a polyurethane cover coat. The primer and cover coat were applied by spraying. The test results showed that the alloy was protected, but not completely, from corrosion in the 3.5 wt % NaCl salt fog environment. The C-ring SCC tests showed that the paint system would not effectively protect the substrate metal from SCC in an aqueous chloride environment because the C-rings failed at flaws in the paint coating. (auth)

53608 (RFP-1904) STRESS-CORROSION CRACKING OF UNDERAGED AND OVERAGED U-2.3 WT PERCENT Nb IN AN AQUEOUS CHLORIDE ENVIRONMENT. Macki, James M.; Kochen, Robert L. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). 4 Aug 1972. Contract AT(29-1)-1106. 6p. Dep. NTIS.

The stress-corrosion cracking (SCC) behaviors of the U-2.3 wt % Nb alloy aged 24 hours at 230°C (underaged) and 24 hours at 430°C (overaged) have been studied. The SCC test utilized smooth, dead-weight loaded, static tensile specimens which were exposed to oxygen-saturated water containing 50 ppM chloride ions. The tests showed that the underaged material was more susceptible to SCC than the overaged material. SCC in the underaged material appeared to proceed by a transgranular fracture mode. The overaged material might not fracture by a SCC mode; but rather, it might fracture by a mechanical mode after corrosion has reduced the cross-sectional areas of the specimens. (auth)

53609 (RT/ING-(72)7) EXPERIMENTAL RESULTS OF SEVERAL TESTS OF FRETTING CORROSION OF METALLIC MATERIAL. Lupoli, P. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 30 Mar 1972. 54p. (In Italian). Dep. NTIS (U. S. Sales Only).

Fretting corrosion at ambient temperature has been investigated for copper/steel couples in water, and for Zircaloy-2/Zircaloy-2, Zircaloy-2/steel, and inconel/Zircaloy-2 couples in water, air, and nitrogen. Fretting corrosion tests were carried out mainly with laboratory equipment, by which the influence of some experimental parameters, such as environment, temperature, slip and frequency of vibrations, specific load, material, and geometry of samples, may be investigated. (auth)

53610 STUDY OF STRESS CORROSION CRACKING OF U-10 PERCENT Mo WIRES: OBSERVATIONS WITH THE FIELD EMISSION MICROSCOPE. Hoenig, Stuart A.; Sulsona, Herman (Univ. of Arizona, Tucson). pp 477-97 of Applications of Field-Ion Microscopy in Physical Metallurgy and Corrosion. /Hochman, R. F. (ed.). Atlanta; Georgia Inst. of Tech. (1969).

From Conference on applications of field-ion microscopy in physical metallurgy and corrosion; Atlanta, GA. (15 May 1968). See CONF-680570.

Aspects of stress corrosion cracking (SCC) such as cracking mode, agents responsible, and protection techniques are discussed. Results of investigations show that stress corrosion cracking of U-10% Mo can be intergranular, transgranular, or both depending upon the specific ambient atmosphere during the stress cycle. Heat treatment can improve the alloy by impeding the motion of dislocations. But this method of generating resistance to SCC is limited because of manufacturing problems. A dry nitrogen environment, during the stress cycle, is protective in the sense that no specimens showed signs of SCC after 1000 stress cycles from zero to 36,000 psi. (J.R.D.)

53611 COMPARISON OF THE OXIDATION PROCESS IN STRONTIUM AND CERIUM BY ULTRAVIOLET PHOTOELECTRON SPECTROSCOPY. Helms, C. R.; Spicer, W. E. (Stanford Electronics Labs., Calif.). Appl. Phys. Lett.; 21: No. 5, 237-9(1 Sep 1972).

The ultraviolet photoemission technique was applied to the study of the oxidation of strontium and cerium. It was found that the photoemission measurement provides a method to determine the oxide growth rate perpendicular to the surface, the composition of the surface, and the stable oxide phases formed during the oxidation process. (auth)

53612 COR-TEN STEEL. PROPERTIES AND USES. Mater. Tech.; No. 4, 97-101(Apr 1972). (In French).

A carbon steel, COR-TEN, was developed which combines excellent corrosion resistance properties with the good mechanical characteristics of carbon steels. The adhesion of paint to this steel, its high temperature characteristics (elastic limit, creep limit when hot, oxidation properties when hot) and resistance to abrasion were studied. It is easy to work and to weld. The principal originality of COR-TEN is its ability to be used without any coatings in rural, urban or industrial environments. It does, however, require painting in marine environments. Some applications of this steel are given, e.g., rolling stock, civil engineering applications, equipment for thermoelectric or thermonuclear power plants (Na heat exchangers for Rapsodie, and sodium cooling sheaths). (France)

53613 OXIDATION PROTECTION OF TANTALUM AND TANTALUM ALLOYS UP TO 1500°C. Fitzer, E.; Schlichting, J. (Univ., Karlsruhe, Ger.). pp 25.1-20 of Proceedings of the 7th Plansee Seminar on Powder Metallurgy of High Temperature Materials. Vol. I. /Benesvosky, F. (ed.). Reutte/Tyrol, Austria; Metallwerk Plansee (1971). (In German).

From 7th Plansee seminar on powder metallurgy of high temperature materials; Reutte/Tyrol, Austria (21 Jun 1971). See CONF-710602-(Vol.1).

A basic research program was conducted on diffusion in silicides and on the oxidation mechanism of silicides. Based on the results, a coating system for tantalum was developed. In stress tests, one millimeter thick plates of pure tantalum with 200 μ coating withstood 1000 hours without destruction of the samples. Thus far, tests at 1200°C were conducted only up to 2500 hours and tests in the critical deep temperature range of oxidation around 800°C were not completed to destruction. The results justified the expectation that the protective action of coating might be much higher than reported in the literature. (H.B.G.)

53614 ASPECTS CONCERNING THE CORROSION BEHAVIOR OF ZIRCONIUM AND ZIRCONIUM ALLOYS IN WATER AT HIGH TEMPERATURE. Popescu, Elena; Lazarescu, Adriana; Mandru, Galina. Rev. Coroz.; 2: No. 2, 79-85(1972). (In Rumanian).

The general aspects of the corrosion of zirconium and its alloys, at high temperature, in water, are discussed. The influence of internal and external factors on corrosion has been examined. The action of impurities such as hydrogen, nitrogen, oxygen and carbon which diminish the chemical, mechanical and corrosive properties of the metals is pointed out. Temperature, thermic cycling and vibrations particularly influence the corrosion resistance of the metals. (auth)

Preparation and Fabrication

Refer also to abstracts 53037, 53139, 53577-53579, 53587, and 53595.

53615 (SC-DC-722284) FUNDAMENTALS OF ION PLATING. Mattox, D. M. (Sandia Labs., Albuquerque, N. Mex.). 1972. 26p. (CONF-721003-3). Dep. NTIS.

From nineteenth national vacuum symposium; Chicago, IL. (2 Oct 1972).

The term ion plating is applied to atomistic film deposition processes in which the substrate is subjected to a flux of high-energy ions sufficient to cause appreciable sputtering before and during interface formation. The fundamental concepts of ion plating are reviewed along with a discussion of problems peculiar to this deposition process. Several representative applications are described. From the standpoint of adhesion, the principal benefits obtained from ion plating are (1) ability to sputter clean the surface and maintain it "clean" until the film begins to form; (2) provide a high-energy flux to the substrate surface giving a high surface temperature without necessitating bulk heating, thus enhancing diffusion, chemical reaction, etc.; and (3) alter the surface and interfacial structure by introducing high defect concentration, physically mixing the film and substrate material, and influencing the nucleation and growth of the depositing film. Another effect found in the ion plating process is the very great "throwing power" of the depositing film material. It is shown that ion plating is particularly effective in obtaining good adhesion in some systems where conventional deposition techniques give poor results. (auth)

53616 STRENGTHENING OF TUNGSTEN BY POWDER METALLURGICAL INTERNAL OXIDATION. Blickensderfer, Robert; Copeland, Mark I.; O'Brien, William L. (Bureau of Mines, Albany, Oreg.). Int. J. Powder Met.; 8: No. 3, 145-55(Jul 1972).

Tungsten alloys with excellent tensile strength and stress-rupture properties at 1,650°C and 1,920 C were prepared from powder blends of tungsten and W_2Zr or ZrN. The strengthening was attributed to solid solution strengthening by zirconium and to submicron particles of ZrO_2. (auth)

53617 PROBLEMS IN POWDER MIXING. Hausner, Henry H. (Polytechnic Inst. of Brooklyn). pp 5.1-21 of Proceedings of the 7th Plansee Seminar on Powder Metallurgy of High Temperature Materials. Vol. I. /Benesvosky, F. (ed.). Reutte/Tyrol, Austria; Metallwerk Plansee (1971).

From 7th Plansee seminar on powder metallurgy of high temperature materials; Reutte/Tyrol, Austria (21 Jun 1971). See CONF-710602-(Vol.1).

Attempts were made to establish a general point of view that

could be helpful in a better understanding of the mixing process and to establish optimum conditions for mixing various powders of different materials, particle sizes, shapes, and amounts. The friction conditions in a powder mass were studied and analyzed, and friction behavior was correlated with the behavior of the powder in the mixer. Examples are given that clearly indicate that the friction conditions during the mixing play an important role in the mixing process. (P.C.H.)

53618 SIMPLE HOT ISOSTAT FOR BERYLLIUM. Lowe, J. N.; Knight, R. A. pp 9.1-4 of Proceedings of the 7th Plansee Seminar on Powder Metallurgy of High Temperature Materials. Vol. I. /Benesvosky, F. (ed.). Reutte/Tyrol, Austria; Metallwerk Plansee (1971).

From 7th Plansee seminar on powder metallurgy of high temperature materials; Reutte/Tyrol, Austria (21 Jun 1971). See CONF-710602-(Vol.1).

A simple and economic hot isostatic pressing technique was developed for the manufacture of Be thin wall tubes. Basically, powder is vibrated into an annulus formed between a graphite outer die and an inner steel membrane. This assembly is HF heated under vacuum and at the sintering temperature, the membrane is pressurized by high-pressure gas (up to 2000 psi) and expanded to consolidate the powder against the die wall. The method is simple, safe to operate, and is easily accommodated within existing equipment with the minimum of modifications. (auth)

53619 POSSIBILITIES OF EXPLOSIVE COMPACTION OF POWDERS, ESPECIALLY THOSE OF TUNGSTEN, WITH THE DIRECT PROCEDURE. Schmidt, D.; Bock-Nussbaum, Fr.; Pruemmer, R.; Balzerowiak, H. P. pp 11.1-7 of Proceedings of the 7th Plansee Seminar on Powder Metallurgy of High Temperature Materials. Vol. I. /Benesvosky, F. (ed.). Reutte/Tyrol, Austria; Metallwerk Plansee (1971). (In German).

From 7th Plansee seminar on powder metallurgy of high temperature materials; Reutte/Tyrol, Austria (21 Jun 1971). See CONF-710602-(Vol.1).

Following a short survey of the possibility of explosive powder compaction, experimental compaction studies on tungsten powder are described. Results showed that compaction of cylindrical samples can be achieved to a final density of about 95% of the theoretical value. The significant parameters are reported for explosive compaction of tungsten powder, such as type and amount of explosives. (tr-auth)

53620 MATERIAL TRANSPORT BY DISLOCATION MOTION IN SINTERING. Morgan, C. S. (Oak Ridge National Lab., Tenn.). pp 13.1-10 of Proceedings of the 7th Plansee Seminar on Powder Metallurgy of High Temperature Materials. Vol. I. /Benesvosky, F. (ed.). Reutte/Tyrol, Austria; Metallwerk Plansee (1971).

From 7th Plansee seminar on powder metallurgy of high temperature materials; Reutte/Tyrol, Austria (21 Jun 1971). See CONF-710602-(Vol.1).

Some aspects of sintering mechanisms in refractory materials are considered. Densification kinetics occurring as the temperature of the sintering compact is being increased were not compatible with a diffusion-controlled process. A possible alternative mechanism compatible with the densification kinetics is dislocation slip. Dislocations created during short high-temperature excursions were observed by electron transmission microscopy in partially sintered compacts of MgO and tungsten. The dislocations appeared to contribute to the material transport process and support the probable importance of dislocation slip in sintering of fine particle powders. (auth)

53621 KINETICS AND MECHANISM OF MOLYBDENUM POWDER SINTERING. Uskokovic, D.; Zivkovic, M.; Zivanovic, B.; Ristic, M. M. (Boris Kidric Inst. of Nuclear Science, Belgrade. Univ., Nis, Yugoslavia). pp 16.1-9 of Proceedings of the 7th Plansee Seminar on Powder Metallurgy of High Temperature Materials. Vol. I. /Benesvosky, F. (ed.). Reutte/Tyrol, Austria; Metallwerk Plansee (1971).

From 7th Plansee seminar on powder metallurgy of high temperature materials; Reutte/Tyrol, Austria (21 Jun 1971). See CONF-710602-(Vol.1).

The effects of heating rate from 5 to 50°C/min, on the shrinkage kinetics of disperse molybdenum powder in the temperature range from 1200 to 1450°C were investigated. In the same temperature interval, the shrinkage was also studied by isothermal and step-like heating techniques. On the basis of the experimental data, it was found that kinetic equations for isothermal conditions which include some diffusion mechanism as the responsible mechanism for mass transfer are not applicable in the case of real powder sintering, in the whole temperature and time interval under consideration. On the contrary, it was found that effective diffusion coefficient computed from isothermal shrinkage data is the function both, of sintering temperature and soaking time. (auth)

53622 RECENT DEVELOPMENT IN CVD TUNGSTEN AND MOLYBDENUM. Shroff, A. M.; Delval, G. (Thomson-CSF, Corbeville, France). pp 18.1-15 of Proceedings of the 7th Plansee Seminar on Powder Metallurgy of High Temperature Materials. Vol. I. /Benesvosky, F. (ed.). Reutte/Tyrol, Austria; Metallwerk Plansee (1971).

From 7th Plansee seminar on powder metallurgy of high temperature materials; Reutte/Tyrol, Austria (21 Jun 1971). See CONF-710602-(Vol.1).

Chemical vapor deposition (CVD) of W and Mo by the hydrogen reduction of its fluoride or chloride composite was investigated as a potential fabrication method to supplement or even replace the present metal working methods. From the results it was found that no bubbles were obtained if the deposit was done at the ratio H_2/WF_6 varying from 3 to 6 which means moderate total flow low pressure below 20 torr and relatively high temperature above 700°C. The fluorine content could not be correlated with the presence of bubbles in the deposit, but it seemed that very low fluorine content led to thermal instability of the deposit. The vacuum work function was of the order of 4.7 eV. Surface treatment improved this value by 0.1 eV. The emitters for longtime operation should be realized at a ratio H_2/WF_6 equal to 3, a pressure around 10 torr, and a minimum temperature of 700°C. The working model based on the fact that the adsorbed molecules of impurity change the work function of the substrate and influence the preferential crystal orientation seemed to be a promising one. (P.C.H.)

53623 DEFORMATION AND RECRYSTALLIZATION BEHAVIOR OF SINTERED TANTALUM AND TANTALUM FORMED BY ELECTRON BOMBARDMENT. Alheritiere, E.; Moisan, J.; Molinier, R. (Departement des Recherches et Produits Avances, Argenteuil, France). pp 24.1-12 of Proceedings of the 7th Plansee Seminar on Powder Metallurgy of High Temperature Materials. Vol. I. /Benesvosky, F. (ed.). Reutte/Tyrol, Austria; Metallwerk Plansee (1971). (In French).

From 7th Plansee seminar on powder metallurgy of high temperature materials; Reutte/Tyrol, Austria (21 Jun 1971). See CONF-710602-(Vol.1).

Two procedures to produce tantalum were utilized: first, sintering, and second, fusion through electron bombardment. Cast metal is deformed in a very heterogeneous manner; the gross grains in the cast grow differently according to their orientation. During tempering at 1000 to 1100°C, weakly grown grains restore themselves without recrystallization. The zones with strong growth recrystallize normally. Sintered metal behaves differently: deformation texture is more homogeneous, the recrystallization proceeds more regularly and is finer. (H.B.G.)

53624 SOLID STATE REACTIONS DURING THE POWDER METALLURGICAL PRODUCTION AND FABRICATION OF THE MOLYBDENUM ALLOY TZM. Eck, R. (Metallwerk Plansee AG, Reutte/Tyrol, Austria). pp 31.1-10 of Proceedings of the 7th Plansee Seminar on Powder Metallurgy of High Temperature Materials. Vol. I. /Benesvosky, F. (ed.). Reutte/Tyrol, Austria; Metallwerk Plansee (1971). (In German).

From 7th Plansee seminar on powder metallurgy of high temperature materials; Reutte/Tyrol, Austria (21 Jun 1971). See CONF-710602-(Vol.1).

With special consideration to the sintering process the production of sintered bodies is described for the molybdenum alloy TZM containing 0.5% Ti, 0.07% Zr, and 0.01 to 0.05% C. Reactions of the powdered oxygen and the sinter gas moisture with the alloy elements are discussed. Carbon addition acts during the deoxidation as well as during carbide formation. The sintered TZM can be fabricated with high oxygen content; whereas pure molybdenum fails at much lower oxygen concentrations. Examples are given for the growth and recrystallization behavior of forged TZM and TZM plates in comparison with pure molybdenum. (H.B.G.)

53625 STUDY OF DIFFUSION WELDING OF MOLYBDENUM. Gardes, G.; Jacquin, B.; de la Bastie, J. pp 33.1-10 of Proceedings of the 7th Plansee Seminar on Powder Metallurgy of High Temperature Materials. Vol. II. /Benesvosky, F. (ed.). Reutte/Tyrol, Austria; Metallwerk Plansee (1971). (In French).

From 7th Plansee seminar on powder metallurgy of high temperature materials; Reutte/Tyrol, Austria (21 Jun 1971). See CONF-710602-(Vol.II).

The effects of parameters of time, pressure, and tempering have not been explored entirely thus far. Nevertheless, it appears possible to obtain, with sintered molybdenum, a diffusion weld that possesses a mechanical resistance which is equivalent to the basic material. The quality of the weld essentially depends on smoothness of the contact surface (a deviation of 2 microns is important) and on favorable structure. The latter point is the particular object of this study. (tr-auth)

53626 PRODUCTION OF A Ni-ThO_2 ALLOY WITH A DISPERSED PHASE STARTING FROM ORGANOMETALLIC COM-

POUNDS. Marty, Michel; Walder, Andre; Hivert, Andre (Office National d'Etudes et de Recherches Aerospatiales, Chatillon, France). pp 37.1-12 of Proceedings of the 7th Plansee Seminar on Powder Metallurgy of High Temperature Materials. Vol. II. /Benesvosky, F. (ed.). Reutte/Tyrol, Austria; Metallwerk Plansee (1971). (In French).

From 7th Plansee seminar on powder metallurgy of high temperature materials; Reutte/Tyrol, Austria (21 Jun 1971). See CONF-710602-(Vol.2).

The Onera method for the production of a Ni–ThO_2 alloy avoids the principal difficulties inherent in wet methods. First of all, the choice of thorium as a component yields a fine dispersion of thorium during high-temperature treatment. Second, the use of poly-(methylmethacrylate) as stabilizer of the suspension avoids, among other factors, difficulties associated with the elimination of the solvent. The diverse operations involved in the procedure as well as the various parameters entering each step permit an understanding of the relatively slow development of these particular types of alloys of which Ni–ThO_2 is one of the first examples. (tr-auth)

53627 PRODUCTION OF Ni–Cr–ThO_2 ALLOYS BY MEANS OF CHROMIUM DIFFUSION THROUGH HALOGEN CARRIER IN A $NiThO_2$ GRAIN. Marty, Michel; Walder, Andre; Galmiche, Philippe; Hivert, Andre (Office National d'Etudes et de Recherches Aerospatiales, Chatillon, France). pp 38.1-11 of Proceedings of the 7th Plansee Seminar on Powder Metallurgy of High Temperature Materials. Vol. II. /Benesvosky, F. (ed.). Reutte/Tyrol, Austria; Metallwerk Plansee (1971). (In French).

From 7th Plansee seminar on powder metallurgy of high temperature materials; Reutte/Tyrol, Austria (21 Jun 1971). See CONF-710602-(Vol.2).

Since their appearance on the market, Ni–Th, and especially Ni–Cr–Th, have elicited great interest because of their remarkable mechanical properties at high temperatures. Among materials possessing similar thermomechanical properties, they are the only ones that can be laminated. Although not possessing great practical interest because of oxidizibility, Ni–Th has the merit of being first in a new series of alloys for high temperatures and has contributed to better understanding of certain mechanisms of reinforcement. In sharp contrast, Ni–Cr–Th is suitable for practical application. In the USA, for example, it is used in elements of space rockets, reaching maximal temperatures of about 1200°C. The work performed under Onera, as is presented, proposes an original technique for production of this type of material. Chromium incorporation through an intermediary gaseous halogen phase into the elementary grains of Ni–Th permits the production of a homogeneous Ni–Cr–Th alloy without non-diffused chromium inclusions and very small content of chromium oxide. Study of the various parameters, entering into the thermomechanical treatment, permits the definition of laminating conditions which confer to the material a lifetime of 100 h at 1050°C under 5 hectobars. (tr-auth)

53628 ELECTRIC DISCHARGE-TYPE ACTIVATED PRESSURE SINTERING AND BONDING OF A SUPERALLOY COMPOSITE STRUCTURE. Goetzel, C. G. (Lockheed Palo Alto Research Lab., Calif.). pp 40.1-9 of Proceedings of the 7th Plansee Seminar on Powder Metallurgy of High Temperature Materials. Vol. II. /Benesvosky, F. (ed.). Reutte/Tyrol, Austria; Metallwerk Plansee (1971).

From 7th Plansee seminar on powder metallurgy of high temperature materials; Reutte/Tyrol, Austria (21 Jun 1971). See CONF-710602-(Vol.2).

Electric discharge-type activated hot pressing, known as spark sintering, has been successfully employed in the commercial production of beryllium parts for aerospace applications. The process has also been used experimentally for the consolidation of titanium alloy and superalloy powders into forging preforms. Composite structures combining powder and wrought-metal shapes appear to be one of the most interesting applications of the process. The inherently short combined consolidation and bonding cycles tend to reduce adverse reactions or degradation at the interfaces of disparate metals. In composites of the same material but of different state, the process parameters can be adjusted to produce fully dense powder sections joined solidly to sheet or plate by metallurgical bond zones while grain size and distortions are controlled. This type of structure should be of considerable interest in view of the substantial materials and labor savings that may be realized. Process parameters were optimized for several types of Inconel 718 superalloy powders. The degree of consolidation and bond integrity between the powder section and the wrought-metal base was observed metallographically, as was the effect of a subsequent diffusion treatment. A special shear test was used to measure the strength of the bond zone. (auth)

53629 SIMPLE METHOD OF PRECISE ALIGNMENT AND UNIFORM DISTRIBUTION OF REINFORCING FIBERS IN A METAL MATRIX. Berghezan, A. (Union Carbide European Research Associated, Brussels). pp 45.1-17 of Proceedings of the 7th Plansee Seminar on Powder Metallurgy of High Temperature Materials. Vol. II. /Benesvosky, F. (ed.). Reutte/Tyrol, Austria; Metallwerk Plansee (1971).

From 7th Plansee seminar on powder metallurgy of high temperature materials; Reutte/Tyrol, Austria (21 Jun 1971). See CONF-710602-(Vol.2).

A simple method of incorporation of reinforcing fibers in a metal matrix has been developed and tested. It permits both a precise alignment and a perfect uniform distribution of the fibers in a metal matrix. The method is described in two variants and examples of composite materials prepared upon each variant are given. The method appears very versatile as it allows the incorporation of any kind of fibers such as rigid or flexible metallic fibers and ceramic or carbon filaments, etc., in a metal matrix. Additionally, it allows the incorporation of any volume fraction of fibers and is particularly suitable for the incorporation of high volume fractions. Materials have been prepared in different shapes such as heavy bars or in a sheet form. (auth)

53630 ROLLING IN VACUUM. Krupin, A. V. (Inst. of Steel and Alloy, Moscow). pp 19.1-24 of Proceedings of the 7th Plansee Seminar on Powder Metallurgy of High Temperature Materials. Vol. IV. /Benesvosky, F. (ed.). Reutte/Tyrol, Austria; Metallwerk Plansee (1971). (In German).

From 7th Plansee seminar on powder metallurgy of high temperature materials; Reutte/Tyrol, Austria (21 Jun 1971). See CONF-710602-(Vol.4).

The international status of the rolling of hard metals and their alloys is surveyed. Especially discussed are reactions between gases and metals during their high-temperature fabrication under vacuum; the effects of rolling in vacuum on fine structure and properties of metals, alloys, and bimetals; and influence of fabrication in vacuum on conditions and parameters of the rolling process. (52 references). (H.B.G.)

53631 HIGH DENSITY P/M COMPONENTS FOR ELEVATED TEMPERATURE APPLICATIONS. Reichman, S. H.; Smythe, J. W. pp 35.1-13 of Proceedings of the 7th Plansee Seminar on Powder Metallurgy of High Temperature Materials. Vol. IV. /Benesvosky, F. (ed.). Reutte/Tyrol, Austria; Metallwerk Plansee (1971).

From 7th Plansee seminar on powder metallurgy of high temperature materials; Reutte/Tyrol, Austria (21 Jun 1971). See CONF-710602-(Vol.4).

The Federal–Mogul Corporation, Metal Powder Division approach to superalloy powder-metallurgy is given. The process whereby molten metal is inert gas-atomized to low interstitial content powders and subsequently densified by extrusion is shown relative to other consolidation methods. Superior intermediate temperature mechanical properties to 1400°F are given for the P/M nickel-based superalloys and comparisons drawn to cast/wrought counterparts. The principal properties discussed are tensile and stress rupture for the alloys IN-100, U-700, Waspaloy, and Rene 95. Examples of conventional forging and superplastic forging are given, and mechanical properties of material forged by each method are given. The superiority of the P/M alloys is evident in both forming methods. An experimental thermomechanical process is discussed in which coarse grained and single crystal structures are produced in the U-700 alloy. Material so processed showed enhanced mechanical properties (including 1800°F stress rupture lives). A series of low carbon P/M based alloys is explained, which permits rapid grain growth for good 1800°F stress rupture properties. The potential of these alloys is shown for a total process of superplastic forming, heat treating to large grain structures, and carburizing the resultant grain boundaries for stability. (auth)

53632 ELECTRONIC MECHANISM OF THE BASIC TECHNOLOGICAL PROCESSES IN THE POWDER METALLURGY OF HIGH TEMPERATURE MATERIALS. Samsonov, G. V.; Upadhyaya, G. S. (Inst. of Materials Science, Kiev. Univ. of Roorkee, India). pp 49.1-22 of Proceedings of the 7th Plansee Seminar on Powder Metallurgy of High Temperature Materials. Vol. IV. /Benesvosky, F. (ed.). Reutte/Tyrol, Austria; Metallwerk Plansee (1971).

From 7th Plansee seminar on powder metallurgy of high temperature materials; Reutte/Tyrol, Austria (21 Jun 1971). See CONF-710602-(Vol.4).

Progress in the field of basic powder metallurgical processes has so far been based mainly on physical or physicochemical concepts. An attempt has been made to review the complete picture on the basis of the stable electronic configuration model of the condensed state. Metal powder production by the reduction method

can be visualized as a donation of electrons from the reducing agent to the metal ions; the reduction rate naturally depends on the electron donor capacity. During pressing of metal powders, apart from macroscopic and microscopic changes, there is sufficient scope for electronic exchange between the excited atoms and this suggests a very great similarity between the processes of pressing and sintering. Numerous attempts at theoretical interpretations of the sintering mechanism viz., chemical reactions at the surface and boundaries of particles, surface and volume diffusion, and thermally activated dislocation processes have achieved some success, but only in the interpretation of phenomena typical for individual sintering stages. However, the present model presents the different sintering stages in a coherent picture. Various examples have been adduced from the field of powder metallurgy of the refractory metals and their compounds in order to justify the unified approach of the electronic configuration model. (auth)

53633 OUTLOOK FOR THE ON-SITE WELDING OF THICK METAL SHEETS. Roudier, R.; Bachelay, J.; Thome, P. (CEN de Saclay, Gif-sur-Yvette, France). Soudage Tech. Connexes; 26: No. 5, 196-209(May 1972). (In French).

Electron welding may be used to weld large structures, portable welding equipment being used. Structures such as the large diameter skirtings, the tubular plates of exchangers, the lid of the dissolver, and the Phenix valve tank can be handled in this way. Systematic research on the state of the surfaces of the parts to be joined and the chamfered edges, the gaps between these parts, and the welding position confirmed that this technique is compatible with ordinary workshop facilities. The welding can be effected rapidly and for any position of the parts. The weld penetrates very deeply into these parts. The technique has thus widespread applications. (France)

Properties, Structure, and Phase Studies

Refer also to abstracts 52956, 53033, 53116, 53125, 53551, 53589, 53590, 55023, 55036, 55040, 55052, and 55178.

53634 (CONF-720806-3) EFFECTS OF STRAIN GRADIENTS ON THE GROSS STRAIN CRACK TOLERANCE OF A 533-B STEEL. Randall, P. N. (TRW Systems, Redondo Beach, Calif.); Merkle, J. G. (Oak Ridge National Lab., Tenn.). 1972. Subcontract 3134. 28p. Dep. NTIS.

From sixth national symposium on fracture mechanics; Philadelphia, Pa. (28 Aug 1972).

To satisfy the need for a measure of fracture toughness at stress levels above yield, a quantity called gross strain crack tolerance has been proposed. It is the total elastic-plus-plastic strain measured at maximum load in a laboratory test of a specimen containing a surface crack, and is of course a function of crack size and temperature. The object has been to develop the test to produce results that can be used to estimate the tolerance of material in full-scale hardware for strain in the presence of a crack. Previous work utilized precracked tensile specimens of A 533-B steel to study the effects of specimen geometry and crack size as a function of temperature. Now, the effects of strain gradients have been studied by loading the specimen in bending or by placing the crack in the bottom of a groove. Analysis of the displacement measurements showed that proper characterization of all the strain gradients tested required consideration of the strain values at two locations. The first, defined as the gross strain crack tolerance (GSCT), was located in the net section normal to the crack plane at mid-crack depth, the approximate location along the crack border where fracture originated. The second strain value was the gross strain on the back face in the gross section above and below the crack. At temperatures within the transition region, GSCT increased in direct proportion to the degree of tensile strain on the back face of the gross section. Tests in bending, which put the neutral axis between the crack tip and the back face, produced the lowest value of GSCT, while those in which the crack propagated into regions of increasing strain yielded the highest GSCT. These effects were attributed to the influence of back face strain on the development of the plastic zone and consequent relief of constraint. (auth)

53635 (EURFNR-998) INFLUENCE OF THERMOMECHANICAL TREATMENTS ON THE CREEP RUPTURE AND CREEP BEHAVIOR OF X10 NiCrMoTiB 1515 STEEL. Schirra, M. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Material und Festkoerperforschung). Translation of report KFK-1535. 53p. Dep. NTIS.

Work Performed under United States-Euratom Fast Reactor Exchange Program.

In order to study the influence of different thermomechanical treatments on the creep behavior and time-to-rupture of stainless steel X10 NiCrMoTiB 1515 (DIN 1.4970) samples of seven different pretreatments were investigated. The reason for this investigation was the fact that the yield point of austenitic steels at high temperatures (600 to 800°C) is in the range 12 to 15 kp/mm^2. With respect to the requirements for fuel-clad there exists the necessity to increase the strength, particularly the yield point by way of proper treatment. Specimens made from the same heat of a Sandvik steel (12R72HV) were investigated after solution treatment in the temperature range 550 to 800°C and after thermomechanical treatments at 650, 700, and 750°C. Among the pretreatments employed were coldwork and annealing 15 and 30% respectively, at temperatures between 700 to 850°C. It was found that 15% coldwork improved the time-to-rupture most for times >10^4 hours and temperatures between 650 and 700°C. The ductility decreased for specimens which were only solution treated with increasing time to rupture, while on the other hand it was time independent for samples which underwent a mechanical or thermomechanical treatment. The important creep-data for designing fuel-element-cladding are given for all thermomechanical pretreatments for a wide range of stresses. The metallographic investigations gave insight into crack formation, fracture, and changes in the grain structure. (auth)

53636 (IS-T-554) DIFFUSION IN DILUTE BISMUTH-MERCURY AND LEAD-MERCURY SYSTEMS. Smith, D. L. (Ames Lab., Iowa). Aug 1972. Contract W-7405-eng-82. 65p. Dep. NTIS.

Thesis.

Diffusion coefficients for dilute liquid solutions of lead in mercury and bismuth in mercury at 25°C were determined. A capillary-reservoir experimental technique was used in which the capillary composition profile was periodically monitored. The composition was determined from voltage drops, converted to resistivities. Resistivity-composition relations for the two systems were determined experimentally. Diffusivities calculated for both the lead and bismuth systems were found to follow the same composition dependency. A second-degree polynomial was determined which describes the composition dependence of diffusivity for dilute bismuth and lead amalgams, $D(\times 10^{-5}\ cm^2/sec) = 4.170 - 814.2n + 52181n^2$ for $0.002 \leq n \leq 0.008$, where n is the atom fraction solute. (auth)

53637 (LBL-101) I. LATTICE HEAT CAPACITIES OF ALLOYS AT LOW TEMPERATURES; InPb, AuCd, Mg_3Sb_2. II. EFFECT OF ORDERING ON LATTICE HEAT CAPACITY; $AuCu_3$. Yoon, Hong Il (California Univ., Berkeley. Lawrence Berkeley Lab.). Aug 1971. Contract W-7405-eng-48. 74p. Dep. NTIS.

Thesis.

Heat capacities of three alloys were measured by isothermal calorimetry from 20 to 298°K. The alloys were InPb, endothermically formed from the elements, the moderately exothermic AuCd, and the highly exothermic Mg_3Sb_2. Deviations from Kopp's law of additivity of C_p were rather small, except for a small anomaly of undetermined origin at 240 to 300°K for InPb, and a decided negative deviation (~5%) above 200°K for Mg_3Sb_2. Heat capacities of the $AuCu_3$ alloy in both the ordered and disordered states have been measured between 20 and 298°K by isothermal calorimetry. Combining the heat capacity data for $AuCu_3$ from this study with existing high temperature thermodynamic data, S^o_0, disordered, the configurational entropy, was found to be 0.987 eu, which is somewhat lower than the theoretical value for complete disorder, 1.117 eu. The difference may be explained in terms of short-range order, the existence of which is confirmed by heat of formation measurements with tin solution calorimetry. (T.D.)

53638 (ORNL-4781) BEHAVIOR OF WELDED JOINTS IN STAINLESS AND ALLOY STEELS AT ELEVATED TEMPERATURES. Gilliland, R. G. (Oak Ridge National Lab., Tenn.). Aug 1972. Contract W-7405-eng-26. 62p. Dep. NTIS.

An extensive survey was conducted of the available literature concerning the mechanical properties of weldments in Types 304 and 316 stainless steel and in 2¼ Cr-1 Mo low-alloy steel. The temperature range of interest was 900 to 1300°F. Data on weldments in these materials were found to be sparse, especially for the case of 304 stainless steel. This situation was especially true, for all materials, in the case of cyclic data (fatigue, etc.). Comparisons of weld-metal/base-metal properties and property variations between filler metals are presented. These data are evaluated with regard to service and fabrication application and experience, and the effect of service-oriented microstructural changes on component integrity is discussed. Finally, recommendations are presented as to additional data and investigations needed to more fully understand the behavior of welded joints in stainless and alloy steels at elevated temperatures. (auth)

53639 (ORO-3262-25) DEFORMATION PROCESSES IN HEXAGONAL METALS. Progress Report, December 1, 1971-

November 30, 1972. Garde, A. M.; Reed-Hill, R. E. (Florida Univ., Gainesville). 1972. Contract AT(40-1)-3262. 35p. Dep. NTIS.

Five papers in preparation and nearing completion are discussed. These show that lowering the impurity level of zirconium from about 2000 ppM (commercial purity) to about 200 ppM strongly affects a number of its mechanical properties. First, the very low twinning rate of commercial purity zirconium (longitudinal specimens) at 77°K is markedly increased. This changes the stress-strain curve shape from nearly parabolic to approximately linear with a corresponding increase in tensile elongation by a factor of three to four. Several stages of deformation were observed in the high-purity zirconium stress-strain curve that can be related to changes in the twinning pattern that occur in certain strain intervals. Increasing the purity also markedly lowered the temperature and rate dependence of the flow stress of zirconium below about 600°K. This tended to produce a deformation behavior similar to that observed in pure face-centered cubic metals. The high-purity zirconium data have also allowed the magnitudes of the dynamic strain aging phenomena in zirconium to be estimated. This evaluation shows that in general dynamic strain aging is much weaker in zirconium than it is in titanium. Other work accomplished last year has demonstrated that prestraining titanium at 77°K so as to nucleate twins has beneficial effects on the room temperature mechanical properties. A study to test the validity of the Cottrell–Stokes Law in titanium and zirconium has also been made. (auth)

53640 (RDT-M-2-2-T(8-72)) STAINLESS AND LOW ALLOY STEEL FORGINGS (ASME SA-182 WITH ADDITIONAL REQUIREMENTS). (Division of Reactor Development and Technology (AEC), Washington, D. C.). Aug 1972. 11p. RSO.

A standard prescribing requirements for stainless and low-alloy forgings (ASME SA-182 with additional requirements) for nuclear and associated applications is presented. This standard supersedes RDT M 2-2T dated January 1972. (J.R.D.)

53641 (SC-DR-720471) MECHANICAL PROPERTIES AND STRESS RELAXATION OF BERYLLIUM–COPPER ALLOY 25. Nordstrom, T. V.; Rohde, R. W. (Sandia Labs., Albuquerque, N. Mex.). Aug 1972. 21p. Dep. NTIS.

The mechanical properties of Beryllium–Copper Alloy 25 were investigated. In particular, the proportional limit, yield strength, and ductility were measured from –320 to 300°F for AT and HT strength levels. All three properties varied inversely with temperature. Short term stress relaxation was studied for various strains and temperatures using AT and HT conditions. Fractional relaxation was found to increase with increasing strain. There was no apparent temperature dependence of relaxation. Preliminary relaxation results from long term bend tests are presented. The results thus far agree with extrapolation of the short term testing. Other areas investigated were the effects of deformation after aging on hardness and hardening during relaxation. The results are discussed with respect to safe design criteria for the alloy. (auth)

53642 (STU-70-419/U-350(Pt.1,2)) CHANGE OF STRUCTURE AND MECHANICAL PROPERTIES IN STAINLESS STEEL BY IRRADIATION. PART 1,2. THE INTERRELATIONSHIP OF THE CREEP AND STRESS RELAXATION PHENOMENA. Gott, K.; Lagneborg, R.; Modeer, B. (Aktiebolaget Atomenergi, Studsvik (Sweden)). Sep 1971. 20p. (AE-MF-232).

Creep and stress relaxation tests were performed on a 20 Cr–35 Ni austenitic stainless steel at 700°C. The results were evaluated using the recovery-creep model of Lagneborg and also the steady-state creep power law. Both models were also applied in a slightly modified form to the relaxation results. Good agreement was found between the experimental results and the recovery-creep model. (auth) (Sweden)

53643 INFLUENCE OF INTERSTITIAL NITROGEN ON THE ASYMMETRY OF THE YIELD STRESS OF TANTALUM. Lachenmann, R.; Schultz, H. (Max-Planck-Institut fuer Metallforschung, Stuttgart. Univ., Stuttgart). Scr. Met.; 6: No. 8, 731-6(Aug 1972).

Properties of high-purity and N-doped Ta single crystals were investigated. It was concluded that an asymmetry in yield stress in pure Ta is associated with lattice characteristics. The asymmetry of yield stress is continuously reduced by adding impurity interstitials such as N. (J.R.D.)

53644 NOTE ON THE NATURE OF MASSIVE TRANSFORMATION INTERFACES. Perepezko, J. H.; Massalski, T. B. (Carnegie-Mellon Univ., Pittsburgh). Scr. Met.; 6: No. 8, 743-52(Aug 1972).

Features of the transformation interface of massive transformations in metal systems are discussed. It is noted that in many cases a single-phase massive transformation product forms in a two-phase field. In these cases effective solute partitioning is prevented because of kinetic considerations. A concept of liquid-like structure at massive reaction interfaces is offered in explanation of observed and implied features of such reactions. (J.R.D.)

53645 INFLUENCE OF THE SURFACE ORIENTATION ON YIELD IN Mo SINGLE CRYSTALS. Vesely, D. (Oxford Univ.). Scr. Met.; 6: No. 8, 753-6(Aug 1972).

Results of investigations are presented and discussed which show that slip systems in Mo single crystals are related to the surface effect. It is concluded that surface orientation influences the choice of slip systems and may affect yielding in Mo single crystals at low temperatures. (J.R.D.)

53646 HEAT TREATMENT, MICROSTRUCTURE, AND MECHANICAL PROPERTIES OF HEAVY GAGE STEELS FOR NUCLEAR REACTOR PRESSURE VESSELS. 1. HEAT TREATMENT, MICROSTRUCTURE, AND MECHANICAL PROPERTIES OF Mn–Mo–Ni STEEL PLATE. Miyano, Katao; Shimazaki, Masahide; Hasegawa, Akio (Japan Steel Works, Ltd., Hokkaido). Nippon Seiko Giho; No. 29, 11-19(May 1971). (In Japanese).

The effect of prolonged post-weld heat treatment on the microstructure and mechanical properties is one of the most important subjects not only for the fabrication of nuclear reactor vessels but also for various types of high pressure vessels. The fundamental studies for the effects of quenching, tempering, and prolonged post-weld heat treatment on mechanical properties were carried out for the heavy gage steel plates of Mn–Mo–Ni. The change of mechanical properties caused by prolonged post-weld heat treatment was found to be mainly due to grain growth of ferrite and cohesion of carbide in grain boundary and the formation of molybdenum carbide. (auth) (Japan)

53647 APPLICATIONS OF FIELD-ION MICROSCOPY IN PHYSICAL METALLURGY AND CORROSION. Conference Held at Atlanta, Georgia, May 15–17, 1968. Hochman, R. F.; Mueller, E. W.; Ralph, B. (eds.). Atlanta; Georgia Institute of Technology (1969). 503p. (CONF-680570).

A total of twenty-two papers was presented at the conference. A separate abstract was prepared for each of thirteen papers. Nine papers were not in scope for NSA. (J.R.D.)

For abstracts of individual papers see: 53560, 53610, 53648–53657, and 53704.

53648 ATOM PROBE FIM. Mueller, Erwin W. (Pennsylvania State Univ., University Park). pp 59-65 of Applications of Field-Ion Microscopy in Physical Metallurgy and Corrosion. /Hochman, R. F. (ed.). Atlanta; Georgia Inst. of Tech. (1969).

From Conference on applications of field-ion microscopy in physical metallurgy and corrosion; Atlanta, GA. (15 May 1968). See CONF-680570.

A field ion microscope designed for use in imaging individual atoms is described. The instrument has been used only for testing and calibrating. It is noted that the instrument should be useful in absorption and corrosion studies and in metallography for determining the nature of interstitial segregations, lattice imperfections, and short-range order in alloys. (J.R.D.)

53649 ANALYSIS OF DISLOCATIONS AND STACKING FAULTS BY FIM. Hren, J. J. (Univ. of Florida, Gainesville). pp 87-129 of Applications of Field-Ion Microscopy in Physical Metallurgy and Corrosion. /Hochman, R. F. (ed.). Atlanta; Georgia Inst. of Tech. (1969).

From Conference on applications of field-ion microscopy in physical metallurgy and corrosion; Atlanta, GA. (15 May 1968). See CONF-680570.

Methods for quantitative interpretation of field ion microscopic images from crystal dislocations are described. Discussions are also included on dissociated dislocations and their associated stacking faults. Information is presented on computer simulation of field-ion images of defects, analysis of dislocations in cubic metals, crystal structure of hcp metals, and partial dislocations and stacking faults. (J.R.D.)

53650 STUDIES OF GRAIN BOUNDARIES IN METALS WITH THE FIELD-ION MICROSCOPE. Ranganathan, S. (Banaras Hindu Univ., India). pp 131-54 of Applications of Field-Ion Microscopy in Physical Metallurgy and Corrosion. /Hochman, R. F. (ed.). Atlanta; Georgia Inst. of Tech. (1969).

From Conference on applications of field-ion microscopy in physical metallurgy and corrosion; Atlanta, GA. (15 May 1968). See CONF-680570.

Developments in methods for field-ion microscopic studies are reviewed. Information is included on analysis of grain boundaries, methods for studies of low-angle boundaries, methods for studies of twin boundaries, methods for studies of high angle boundaries, and structures in segregations near grain boundaries. (J.R.D.)

53651 LATTICE DEFORMATION BY MECHANICAL AND ELECTRICAL CONTACTS. Nishikawa, Osamu; Mueller, Erwin W. (Pennsylvania State Univ., University Park). pp 155-76 of Applications of Field-Ion Microscopy in Physical Metallurgy and Corrosion. /Hochman, R. F. (ed.). Atlanta; Georgia Inst. of Tech. (1969).

From Conference on applications of field-ion microscopy in physical metallurgy and corrosion; Atlanta, GA. (15 May 1968). See CONF-680570.

A review is presented of early and recent developments in field-ion microscopic investigations of mechanical and electric contacts. These methods appear to offer promise of yielding new insight into surface topography and processes occurring in the bulk immediately underneath the contact surface. Information is included on contact procedures and results of contacts with hard metals, contacts with soft materials, and contacts with glass. (J.R.D.)

53652 FIELD ION MICROSCOPY OF DILUTE ALLOYS. Machlin, E. S. (Columbia Univ., New York). pp 177-97 of Applications of Field-Ion Microscopy in Physical Metallurgy and Corrosion. /Hochman, R. F. (ed.). Atlanta; Georgia Inst. of Tech. (1969).

From Conference on applications of field-ion microscopy in physical metallurgy and corrosion; Atlanta, GA. (15 May 1968). See CONF-680570.

The state of knowledge concerning the application of field ion microscopy in the study of dilute solid solutions is summarized. The main results obtained from such studies are the interaction energy between solute atoms as a function of their distance of separation and a knowledge of the "molecularity" of the clusters formed by different solute atoms in solid solution. This application of field ion microscopy is in its infancy and has promise of a long and useful life. (auth)

53653 STUDY OF TWO-PHASE SYSTEMS BY FIELD-ION MICROSCOPY. Bayuzick, R. J.; Goodrich, R. S. (Vanderbilt Univ., Nashville). pp 199-229 of Applications of Field-Ion Microscopy in Physical Metallurgy and Corrosion. /Hochman, R. F. (ed.). Atlanta; Georgia Inst. of Tech. (1969).

From Conference on applications of field-ion microscopy in physical metallurgy and corrosion; Atlanta, GA. (15 May 1968). See CONF-680570.

Methods are described for study of crystal phases between which both crystal structure and composition are variable. Developments related to two-phase studies are reviewed and applications of field-ion microscopy to studies of interfaces, nucleation, and growth are described. Applications of field-ion microscopy to studies of dispersion strengthening in two-phase systems are also discussed along with applications in yield strength studies and work hardening studies. (J.R.D.)

53654 STUDY OF ORDERED ALLOYS BY FIELD-ION MICROSCOPY. LeFevre, B. G. (Georgia Inst. of Tech., Atlanta); Newman, R. W. pp 243-69 of Applications of Field-Ion Microscopy in Physical Metallurgy and Corrosion. /Hochman, R. F. (ed.). Atlanta; Georgia Inst. of Tech. (1969).

From Conference on applications of field-ion microscopy in physical metallurgy and corrosion; Atlanta, GA. (15 May 1968). See CONF-680570.

A survey of phenomena associated with atomic order in alloys is presented. Aspects of atomic order which are suited to analysis by field ion microscopy are discussed. A review of the common ordered structures is included along with information on the microstructure of ordered alloys, and image characteristics of domain boundaries. (J.R.D.)

53655 INTERPRETATION OF ALLOY IMAGES. Southworth, H. N.; Ralph, B. (Univ. of Cambridge, Eng.). pp 291-327 of Applications of Field-Ion Microscopy in Physical Metallurgy and Corrosion. /Hochman, R. F. (ed.). Atlanta; Georgia Inst. of Tech. (1969).

From Conference on applications of field-ion microscopy in physical metallurgy and corrosion; Atlanta, GA. (15 May 1968). See CONF-680570.

A unified theory of solid solution imaging is presented. Discussions and analyses supporting the theory are presented in sections on the image from ordered equiatomic PtCo, distinguishing between the atomic species, models for superlattices, the effects of temperature on Pt_3Co, and models for selective ionization. (J.R.D.)

53656 INTERACTION OF SINGLE ATOMS WITH ATOMICALLY DEFINED SURFACES. Plummer, E. W. (National Bureau of Standards, Washington, D. C.). pp 371-89 of Applications of Field-Ion Microscopy in Physical Metallurgy and Corrosion. /Hochman, R. F. (ed.). Atlanta; Georgia Inst. of Tech. (1969).

From Conference on applications of field-ion microscopy in physical metallurgy and corrosion; Atlanta, GA. (15 May 1968). See CONF-680570.

Experiments are described which exemplify the unique types of surface studies possible by the use of field-ion microscopy. A discussion is also included of experiments conducted to measure the surface binding energy of atomic species on W. These examples are used to demonstrate the importance of surface characterization on an atomic scale and the fundamental role that field-ion microscopy has in advanced experiments on metal surfaces. (J.R.D.)

53657 GAS-METAL INTERACTIONS: FIELD ION AND EMISSION MICROSCOPY. Grenga, Helen E.; Hochman, Robert F. (Georgia Inst. of Tech., Atlanta). pp 391-411 of Applications of Field-Ion Microscopy in Physical Metallurgy and Corrosion. /Hochman, R. F. (ed.). Atlanta; Georgia Inst. of Tech. (1969).

From Conference on applications of field-ion microscopy in physical metallurgy and corrosion; Atlanta, GA. (15 May 1968). See CONF-680570.

Field ion microscopy results on gas-metal interactions are reviewed. Results of field ion microscopic studies on material couples for which the mechanical strength is affected by the environment are also presented. Information is included on effects of environment on mechanical strength, hydrogen embrittlement, studies of gas-metal interactions, and field-ion microscopy of Ti and ordered Ti_3Al. (J.R.D.)

53658 INFLUENCE OF HOLD-TIME AND TEMPERATURE ON THE LOW-CYCLE FATIGUE OF INCOLOY 800. Jaske, C. E. (American Society of Mechanical Engineers, New York); Mindlin, H.; Perrin, J. S. J. Eng. Ind.; 94: No. 3, 930-4(Aug 1972).

A study has been conducted to determine the low-cycle fatigue behavior of solution-annealed Incoloy 800 bars at temperatures from 800 to 1400°F. The experimental work included evaluation of specimens under both continuous, completely reversed strain cycling and under strain cycling with hold time periods at the strain limits. At 1000, 1200, and 1400°F, it was found that 10-min hold-times at the tensile strain limit during every cycle significantly reduced the cyclic fatigue life compared with continuous cycling. However, there was little reduction in cyclic fatigue life when 10-min hold-times were introduced at the compressive strain limits or at both the tensile and compressive limits. The ratio of hold-time cyclic fatigue life to no-hold-time cyclic fatigue life decreased as the length of hold time increased (at constant total strain range) and as the magnitude of strain range decreased (at constant hold-time length). (auth)

53659 ORDERING TRANSFORMATION IN Ni_2V. Tanner, L. E. (Kennecott Copper Corp., Lexington, Mass.). Acta Met.; 20: No. 10, 1197-1227(Oct 1972).

The transformation to long-range order in stoichiometric Ni_2V was studied in detail over a wide range of subcritical temperatures. The alloy was subjected to both continuous cooling and isothermal aging treatments and specimens were examined by electron and light optical microscopy and x-ray diffraction techniques. The observations indicate that in the range $920°C > T > 750°C$ the transformation proceeds by means of homogeneous nucleation and growth throughout each disordered grain and heterogeneous nucleation and growth along grain boundaries. At $T \leq 750°C$ homogeneous nucleation appears to be superseded by a continuous transition to LRO. However, heterogeneous nucleation and growth cannot be suppressed during cooling and so this process is also operative at the low temperatures. (auth)

53660 FRACTURE TOUGHNESS TESTING AT CRYOGENIC TEMPERATURES. Symposium Presented at the Seventy-Third Annual Meeting, Toronto, Ontario, Canada, June 21-26, 1970. ASTM Special Technical Publication 496. Philadelphia; American Society for Testing and Materials (1971). 86p. $5.00. (ASTM-STP-496; CONF-700670).

Four articles are included; a separate abstract was prepared for one. The remaining three articles contain information on: plane strain fracture toughness of Al alloys at room and subzero temperatures; influence of specimen design in plane strain fracture toughness testing, and fracture of thin sections containing through and part-through cracks. (P.C.H.)

For an abstract of an individual paper see: 53661.

53661 PLANE STRAIN FRACTURE TOUGHNESS OF SOME CRYOGENIC MATERIALS AT ROOM AND SUBZERO TEMPERATURES. Vishnevsky, C.; Steigerwald, E. A. (TRW Inc., Cleveland). ASTM (Amer. Soc. Test. Mater.) Spec. Tech. Publ.; No. 496, 3-26(1971).

From Fracture toughness testing at cryogenic temperatures symposium; Toronto, Ontario (21 Jun 1970). See ASTM-STP-496; CONF-700670.

An investigation was conducted to measure the plane strain fracture toughness, K_{Ic}, of eight potential cryogenic service alloys at 75, -100, and -321°F. The test materials included 7039-

T61 and 2021-T81 aluminum alloys, Ti-6Al-4V STA in both alpha + beta and beta processed conditions, and the following steels: ASTM A553-A, PH 13-8Mo (H 1150-M), HP 9-4-20, and 18 Ni (200 grade) maraging. Results include both fracture toughness and tensile data as a function of test temperature for each alloy, together with overall comparisons in terms of the plane strain crack size factor $(K_{Ic}/\sigma_{ys})^2$, versus yield strength and yield strength to density ratio. In cases where valid K_{Ic} data could not be generated, the appropriate aspects of the ASTM Tentative Method of Test for Plane Strain Fracture Toughness of Metallic Materials (E 399-70T) are discussed. (auth)

53662 EFFECT OF QUENCHSINTERING ON THE GRAIN-STRUCTURE OF SINTERED METALS. Hausner, H. H. (Polytechnic Inst., Brooklyn). Int. J. Powder Met.; 8: No. 3, 159-61(Jul 1972).

Results of a study of the effect of quench sintering (interruption of the sintering cycle by rapid cooling and subsequent continuation of the sintering process) on the grain structure of tungsten show that specimens compacted at 2500 psi have more grains (small grains) than those compacted at 50,000 psi. Specimens quenched after 2 hours presintering time and then sintered for an additional 16 hours have approximately 40 to 50% more grain than specimens quenched after 16 hours presintering and then sintered for an additional 2 hours. The earlier interruption of the sintered cycle results in finer grains. The final densities of the specimens depend on compacting pressure, but not on the type sintering cycle. Possible causes for these effects of quench sintering on grain structure are proposed. (D.H.M.)

53663 THERMODYNAMIC PROPERTIES OF ZIRCONIUM-CADMIUM AND CERTAIN OTHER SOLID SOLUTIONS. Frye, J. H. Jr.; Betterton, J. O. Jr.; Easton, D. S. (Oak Ridge National Lab., Tenn.). Acta Met.; 20: No. 10, 1183-95(Oct 1972).

The phase diagram was determined up to a concentration of 20 at.% Cd, and lattice parameters were measured for the hexagonal phase. The vapor pressure of cadmium in equilibrium with the solid solution was measured for both the hexagonal and cubic phases as a function of temperature and concentration. These data are considered together with earlier data on the Zr-Ag, Zr-In, Zr-Sn and Zr-Sb primary substitutional solid solutions. Empirical relations are found between the hexagonal (c/a) ratio, the temperature of the transformation from cubic to hexagonal zirconium and the electronic specific heat coefficient on the one hand and the concentration of principal quantum number 5 electrons on the other. These simple relations suggest the possibility that the principal quantum number 5 electrons are entering a rigid conduction band in zirconium. In order to investigate this possibility, the partial molal energy of cadmium in zirconium was calculated from the vapor pressure measurements. It was concluded that the rigid band model is a bad approximation and points out that this is in accord with recent quantum mechanical calculations. Furthermore, the effect of cadmium on the transformation temperature of zirconium is the resultant of two opposite and nearly balanced effects — an absolute zero energy effect which tends to stabilize the cubic form and an entropy effect which tends to stabilize the hexagonal form. Finally, it is shown that, for most of the solutions considered here, the energy of a Wigner-Seitz polyhedron is independent of concentration within experimental error. (auth)

53664 MUTUAL INTERACTIONS OF THORIUM, LANTHANIDES, AND BISMUTH IN Th-Ln-Bi SOLUTIONS: EVIDENCE FOR THE FORMATION OF $ThLnBi_y$ COMPOUNDS. Smith, F. J. (Oak Ridge National Lab., Tenn.). J. Less-Common Metals; 29: 73-9(1972).

The mutual solubilities of thorium, and lanthanum, neodymium, or europium in bismuth solution have been determined over the temperature range 350 to 700°C. Thorium and each lanthanide (Ln), dissolved in liquid bismuth, were found to interact to produce a solid compound with the apparent composition $ThLnBi_y$. The variation of the mole fraction solubility products with temperature can be expressed as $\log K_{sp} = \log(N_{Th}N_{Ln}) = 2.410 - 6480/T(K)$ for $ThLaBi_y$ and $\log K_{sp} = 3.233 - 7285/T(K)$ for $ThNdBi_y$. The standard free energies of formation for $ThLaBi_y$ and $ThNdBi_y$ were estimated to be about $(-114.8 + 0.0208T)$ and $(-99.8 + 0.0207T)$ kcal/mole, respectively. The solubility of europium in bismuth was determined over the temperature range 350 - 550°C. The data can be represented by the expression: $\log S_{Eu}$ (wt %) = 4.4823 - 2973/T(K). (auth)

53665 NUMERICAL CALCULATION OF THE REDISTRIBUTION OF AN INTERSTITIAL SOLUTE IN A THERMAL GRADIENT. Marino, G. P. (Bettis Atomic Power Lab., West Mifflin, Pa.). Nucl. Sci. Eng.; 49: No. 1, 93-8(Sep 1972).

An analytical method is described for calculation of the concentration profile of an interstitial solute of finite solubility in an alloy under a given thermal gradient. The method requires that the diffusion coefficient, the terminal solid solubility, and the heat of transport of the solute be known. The work is applied to the experimental conditions of Sawatzky and of Markowitz for hydrogen in Zircaloy. The agreement between the predicted profiles and the experimentally determined profiles is quite good for total concentrations less than ~1000 ppM. For concentrations greater than this, some deviation is seen but the overall agreement is still considered good within the accuracy of the assumptions employed. The principles embodied in the analysis are easily generalized to include multidimensional thermal and concentration gradients. (auth)

53666 ULTRA-FAST SOLUTE DIFFUSION IN α-Ti AND α-Zr. Hood, G. M.; Schultz, R. J. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Phil. Mag.; 26: No. 2, 329-36(Aug 1972).

Diffusion of ^{63}Ni in polycrystalline α-Ti and of ^{59}Fe, ^{60}Co, and ^{63}Ni in α-Zr was measured. In α-Zr, single crystals were used for studies of Ni and Co diffusion, while the experiments on Fe diffusion were done on polycrystalline specimens. All the solutes studied exhibited extremely fast diffusion compared to self-diffusion in the host metals. It is suggested that these solutes diffuse by an interstitial mechanism and that very fast solute diffusion in the bcc forms of Ti and Zr may be predominantly of an interstitial nature. (auth)

53667 INTERCONNECTING PHENOMENA OF ULTRAPLASTICITY OF ALLOYS AND THEIR CHEMICAL AND PHASE COMPOSITION. Tikhonov, A. S. Fiz. Khim. Obrab. Mater.; No. 1, 159-61(1972). (In Russian).

The mechanical properties of a Ni-33% Mo alloy were investigated during tension experiments over the temperature range 800 to 1,200°C. The phenomenon of ultraplasticity was detected in deformation of the alloy at 900 to 1,100°C, corresponding to the two-phase region Ni + δ in the phase composition diagram Ni-Mo. For the preservation of "micro-structural" factors, the phenomena of ultraplasticity may predominate over such important considerations as the temperature factor of plastic deformation. (tr-auth)

53668 INVESTIGATION OF THE SURFACE OF TUNGSTEN SINGLE CRYSTALS FOLLOWING ELECTRO-EROSIVE TREATMENT. Zolotykh, B. N.; Marchuk, A. I.; Sen'kina, M. S. Fiz. Khim. Obrab. Mater.; No. 1, 145-50(1972). (In Russian).

Results of experimental investigations of the electro-erosive action on single crystals of W are presented. The effects of electric pulses and of the crystallographic orientation of the crystal face of W on the magnitude of the erosion and the character of the disintegration of the surface layers were studied. Brittle shattering of the single crystals along the sliding surfaces may play a decisive role in electro-erosive treatment, equally with evaporation and melting. (tr-auth)

53669 EFFECT OF CHROMIUM AND ZIRCONIUM ON THE DUCTILITY OF COPPER. Chervyakova, V. V. Tr. Inst. Yadern. Fiz., Akad. Nauk Kaz. SSR; 12: 3-6(1971). (In Russian).

The mechanical properties of cast and deformed samples of chromium and chromium-zirconium bronzes were investigated at two elongation rates: 1 and 4 mm/min. The ductility of copper at moderate temperatures increased when alloyed with Cr and Zr. The ductility of Cu and its Cr- and Zr- alloys was measured as a function of temperature up to about 900°C. An increase in the tensile strength limits of these alloys at 300 to 500°C was observed, which was associated with aging. (K.S.W.)

53670 DEFORMATION TEXTURES OF B.C.C. METALS (TUNGSTEN). Rieck, G. D. (Univ. of Tech., Eindhoven, Netherlands). pp 20.1-9 of Proceedings of the 7th Plansee Seminar on Powder Metallurgy of High Temperature Materials. Vol. I. /Benesvosky, F. (ed.). Reutte/Tyrol, Austria; Metallwerk Plansee (1971).

From 7th Plansee seminar on powder metallurgy of high temperature materials; Reutte/Tyrol, Austria (21 Jun 1971). See CONF-710602-(Vol.1).

The experimental details of texture resulting from swaging and drawing of bcc metals (tungsten) are discussed. A consistent picture of the drawing texture of polycrystalline W seems to be available now. This may be the base for future models on deformation mechanism. (auth)

53671 THERMODYNAMIC DESCRIPTION OF THE METAL-RICH REGION IN THE SYSTEM NIOBIUM-MOLYBDENUM-NITROGEN. Hoerz, G.; Steinheil, E. (Max-Planck-Institut fuer Metallforschung, Stuttgart). pp 27.1-18 of Proceedings of the 7th Plansee Seminar on Powder Metallurgy of High Temperature Materials. Vol. I. /Benesvosky, F. (ed.). Reutte/Tyrol, Austria; Metallwerk Plansee (1971). (In German).

From 7th Plansee seminar on powder metallurgy of high temperature materials; Reutte/Tyrol, Austria (21 Jun 1971). See CONF-710602-(Vol.1).

In the system Nb–Mo–N for the range of the ternary α-Nb–Mo–N solid solution, the equilibrium nitrogen concentration as a function of pressure (10^{-4} to 5×10^{2} torr), temperature (1600 to 2400°C), and Mo-concentration (0 to 100 at.%) has been measured as well as the solubility limit of nitrogen in the α solid solution as a function of temperature (1600 to 2100°C) and Mo-concentration (0 to 80 at.%). In addition the kinetics of the dissolution of nitrogen in the α solid solution were determined. The studies were carried out using a gravimetric method and thin disc shaped specimens which were heated by induction. The results showed that the equilibrium nitrogen concentration in the α solid solution obeys the Sieverts $\sqrt{p}$ law and decreases by 3 to 5 orders of magnitude, when the Mo concentration is increased from 0 to 100 at.% at constant pressure and temperature. The enthalpy of solution of nitrogen increased between 0 and 100 at.% Mo from −46,0 kcal/½ mole N_2 (exothermic reaction) to +19,9 kcal/½ mole N_2 (endothermic reaction) and was 0 at about 80 at.% Mo. The saturation concentration of nitrogen in the α solid solution decreased between 0 and 80 at.% Mo by 1 to 2 orders of magnitude, depending on temperature, while the corresponding equilibrium nitrogen pressure increased by many orders of magnitude. The β-nitride in equilibrium with the saturated α solid solution had the hexagonal structure of the subnitride Nb_2N up to Mo concentrations of at least 30 at.%. The initial rate of nitrogen dissolution decreased by about 2 orders of magnitude between 0 and 100 at.% Mo. In the system Nb–N the rate determining step was dissociation and chemisorption. A thermodynamic description of the metal rich region of the system Nb–Mo–N is given using activity coefficients and interaction coefficients. (auth)

53672 ARC-CAST MOLYBDENUM-BASE TZM ALLOY PROPERTIES AND APPLICATIONS. Briggs, J. Z.; Barr, R. Q. (Climax Molybdenum Co., New York). pp 29,1-39 of Proceedings of the 7th Plansee Seminar on Powder Metallurgy of High Temperature Materials. Vol. I. /Benesvosky, F. (ed.). Reutte/Tyrol, Austria; Metallwerk Plansee (1971).

From 7th Plansee seminar on powder metallurgy of high temperature materials; Reutte/Tyrol, Austria (21 Jun 1971). See CONF-710602-(Vol.1).

During the past 12 years that vacuum-melted TZM has been commercial, considerable information has been developed on its properties. Basically, its physical properties, corrosion resistance, and oxidation resistance are similar to those of unalloyed molybdenum. TZM's advantages over unalloyed molybdenum are its higher recrystallization temperature, which permits retention of work hardening to higher temperatures, and its superior toughness. A major advance over the past 12 years has been improvements in processing and fabricating. It is now feasible to make almost any type of part from TZM, often with conventional equipment, although special care and sometimes preheating are required. TZM was originally developed for the aerospace field in applications where high, hot strength was thought to be necessary. More recently, however, its interesting combination of properties, particularly high thermal conductivity, high stiffness, low thermal expansion, high, hot hardness, and excellent resistance to many molten metals has led to a much broader field of use, including die-casting dies and cores, hot-working dies, mandrels, heating elements, and boats. The future looks bright for TZM as more design engineers become acquainted with its properties and realize that its performance far outweighs its cost in many applications. (167 references). (auth)

53673 PROPERTIES OF A 1300 kg P/M TZM BILLET. Clare, L. P.; Smith, J. S.; Kegel, A. J.; Koss, R. L. (GTE Sylvania Inc., Towanda, Pa.). pp 30,1-19 of Proceedings of the 7th Plansee Seminar on Powder Metallurgy of High Temperature Materials. Vol. I. /Benesvosky, F. (ed.). Reutte/Tyrol, Austria; Metallwerk Plansee (1971).

From 7th Plansee seminar on powder metallurgy of high temperature materials; Reutte/Tyrol, Austria (21 Jun 1971). See CONF-710602-(Vol.1).

Problems associated with the forging of P/M TZM billets are reviewed. The chemical composition, physical properties, and microstructure of an unworked P/M TZM forging billet, 41 cm in diameter by 101 cm long, weighing 1300 kg, are described. (auth)

53674 INFLUENCE OF OXYGEN, CARBON, AND BORON ON THE SINTERING AND STRESS RUPTURE PROPERTIES OF SINTERED NICKEL-BASE SUPERALLOYS. Soler-Gomez, A. J. R.; Todd, A. G. (General Electric Co. Ltd., Wembley, Eng.). pp 36,1-18 of Proceedings of the 7th Plansee Seminar on Powder Metallurgy of High Temperature Materials. Vol. II. /Benesvosky, F. (ed.). Reutte/Tyrol, Austria; Metallwerk Plansee (1971).

From 7th Plansee seminar on powder metallurgy of high temperature materials; Reutte/Tyrol, Austria (21 Jun 1971). See CONF-710602-(Vol.2).

The liquid phase sintering behavior of two nickel base superalloys was investigated using powders with a range of oxygen contents. The influence of carbon and boron on the progress of sintering was determined by examination of shrinkage characteristics and pressure variation in the sintering furnace. The stress-rupture behavior of the various sintered materials was determined and related to composition and sintering characteristics. The results indicated that both boron and carbon counteract the effects of oxygen and aid sintering. The stress-rupture life of both alloys tended to a maximum at particular carbon, boron, and oxygen levels. (auth)

53675 STRUCTURE AND PROPERTIES OF DISPERSION STRENGTHENED COBALT ALLOYS. Drapier, J. M.; Coutsouradis, D.; Habraken, L. (CRM, Liege). pp 39,1-16 of Proceedings of the 7th Plansee Seminar on Powder Metallurgy of High Temperature Materials. Vol. II. /Benesvosky, F. (ed.). Reutte/Tyrol, Austria; Metallwerk Plansee (1971).

From 7th Plansee seminar on powder metallurgy of high temperature materials; Reutte/Tyrol, Austria (21 Jun 1971). See CONF-710602-(Vol.2).

Studies were made on the microstructures and properties of various experimental dispersion hardened alloys in the as-received and in the heat-treated conditions. The alloys included Co–2ThO_2–0.2 Zr, Co–4 ThO_2, Co–10 Ni–2 ThO_2–0.2 Zr, and Co–20 Ni–18 Cr–2 and 4 ThO_2. The techniques used on the microstructural study were mainly light microscopy, transmission electron microscopy on thin foils, x-ray diffraction, and electron microprobe analysis. The effects of variables relative to composition, structure, and processing on the strengthening mechanisms in dispersion-strengthened materials are discussed on the basis of the experimental results and also in terms of data in the literature pertaining to the mechanical strength of related materials. (auth)

53676 STABILITY AND HEAT CORROSION OF ALUMINUM COVERING ON ALLOY INCO 713 C AND ON ALLOYS OF COBALT. Davin, A.; Coutsouradis, D.; Habraken, L. (Univ., Liege). pp 40,1-19 of Proceedings of the 7th Plansee Seminar on Powder Metallurgy of High Temperature Materials. Vol. I. /Benesvosky, F. (ed.). Reutte/Tyrol, Austria; Metallwerk Plansee (1971). (In French).

From 7th Plansee seminar on powder metallurgy of high temperature materials; Reutte/Tyrol, Austria (21 Jun 1971). See CONF-710602-(Vol.2).

Structure as well as stability of aluminum claddings were studied at various temperatures. Results showed that, with Inconel 713, the cladding consisted of two zones. One layer constituted NiAl, the second one was a diffusion zone displaying the phases NiAl and Ni_3Al between which were dispersed particles of Mo_2C, NbC, and Ni–Cr–Mo. In the case of cobalt alloys, the diffusion zone appeared uniform and no precipitations could be observed under the light microscope. Resistance to heat corrosion was studied in combustion gases that were contaminated with sulfur and alkalines. Results showed that an aluminum cladding lengthened the lifetime of Inconel 713 by a factor of about 2 and that of cobalt alloys by a factor of 10 in the temperature range from 800 to 950°C. Ta and Ti additions favorably influenced the chemical stability of the cladding in cobalt alloys. Tungsten caused flaking of the cladding. (H.B.G.)

53677 DIFFUSION MEASUREMENTS IN THE SYSTEMS Pd–V AND Pd–Ti AS WELL AS METAL–CERAMIC SYSTEMS BY MEANS OF A MICROPROBE. Lamparter, Peter; Steeb, Siegfried; Gukelberger, Armin (Max-Planck Inst. for Metal Research, Stuttgart). pp 41,1-28 of Proceedings of the 7th Plansee Seminar on Powder Metallurgy of High Temperature Materials. Vol. II. /Benesvosky, F. (ed.). Reutte/Tyrol, Austria; Metallwerk Plansee (1971).

From 7th Plansee seminar on powder metallurgy of high temperature materials; Reutte/Tyrol, Austria (21 Jun 1971). See CONF-710602-(Vol.2).

In the Pd–V system, solid solutions of V in Pd, Pd_3V, and Pd_2V were observed. The measurement of partial diffusion coefficients is described, and data are tabulated. The existing phase diagram for the system was confirmed. During the annealing of Pd–Ti diffusion couples between 600 and 1000°C, three phases, namely $TiPd_3$, $TiPd_2$, and Ti_2Pd_3 were formed. One other phase whose composition ranged from TiPd to Ti_4Pd_3 was also observed. These results were not in agreement with the existing phase diagram for the system. The largest part of the diffusion layer at temperatures above 700°C was formed by the β phase. The validity of the Arrhenius' law for the temperature dependency of the chemical diffusion coefficient of the β phase was demonstrated. The partial

diffusion coefficients were evaluated from the shift of markers versus the Matano plane at 800 and 900°C. Data on the diffusion of Ti, V, Nb, and Ta in AlN, Si_3N_4, and TiO are tabulated. (P.C.H.)

53678 HIGH-TEMPERATURE CREEP BEHAVIOR OF A TUNGSTEN–3 PERCENT RHENIUM ALLOY WITH THORIUM OXIDE DISPERSION HARDENING OF VARIOUS PARTICLE SHAPES. Wirth, G. pp 23.1-32 of Proceedings of the 7th Plansee Seminar on Powder Metallurgy of High Temperature Materials. Vol. III. /Benesvosky, F. (ed.). Reutte/Tyrol, Austria; Metallwerk Plansee (1971). (In German).

From 7th Plansee seminar on powder metallurgy of high temperature materials; Reutte/Tyrol, Austria (21 Jun 1971). See CONF-710602-(Vol.3).

Creep and time behavior were studied on a W–3Re–2ThO_2 alloy in plate and rod shapes under vacuum in the temperature range from 1800 to 2200°C. Despite finer distribution of the ThO_2 particles in plates, the two types of intermediate products showed the same rate of secondary creep in the entire temperature range studied. Up to 2200°C, time resistance of plates was superior to that of rods. At this temperature, a transformation of the elongated ThO_2 particles took place which was accelerated through creep. By means of electromicroscopic examinations and determinations of the activation energy of creep, grain boundary sliding was found to be the process determining creep rate. This concept also explained behavior of the two intermediate products with respect to creep rate and time resistance. Means for improvement of heat resistance are outlined. (tr-auth)

53679 PREPARATION AND PROPERTIES OF W–Ni–Mo ALLOYS. Barta, J.; Gorni, J.; Kimmel, G. pp 1-12 of Proceedings of the 7th Plansee Seminar on Powder Metallurgy of High Temperature Materials. Vol. IV. /Benesvosky, F. (ed.). Reutte/Tyrol, Austria; Metallwerk Plansee (1971).

From 7th Plansee seminar on powder metallurgy of high temperature materials; Reutte/Tyrol, Austria (21 Jun 1971). See CONF-710602-(Vol.4).

Studies were made on the preparation, phase distribution and composition, and mechanical properties of W-base–Ni–Mo alloys. The results showed that improvement of the mechanical properties of the alloys should be obtained if the macro-pores formed during sintering can be avoided and a thermal treatment given after sintering. It is suggested that the potential advantages of these alloys compared to the known heavy metals would be higher hardness and better corrosion resistance than those containing Fe. (P.C.H.)

53680 NEW DEVELOPMENTS IN THE PREPARATION OF COMPOSITE POWDERS. Kunda, W. pp 1-13 of Proceedings of the 7th Plansee Seminar on Powder Metallurgy of High Temperature Materials. Vol. IV. /Benesvosky, F. (ed.). Reutte/Tyrol, Austria; Metallwerk Plansee (1971).

From 7th Plansee seminar on powder metallurgy of high temperature materials; Reutte/Tyrol, Austria (21 Jun 1971). See CONF-710602-(Vol.4).

Composite powders were prepared by the deposition of metals from aqueous solution onto various core materials by gaseous hydrogen at elevated temperature and pressure. The results showed that this technique can be applied for coating of many metals, metalloids, metal alloys, non-metallic elements, refractory materials, and plastics. Nickel is a very suitable material for coating, however, under proper conditions, other metals such as cobalt, molybdenum, copper, and silver alone or in combinations of two or more metals, can also be applied for coating. The physical properties and chemical compositions of some of the composite powders prepared are listed. Areas for the application of composite powders are enumerated. (auth)

53681 METALLOGRAPHY OF CAST TUNGSTEN. Savitskii, E. M.; Povarova, K. B. (Inst. of Metallurgy, Moscow). pp 1-17 of Proceedings of the 7th Plansee Seminar on Powder Metallurgy of High Temperature Materials. Vol. IV. /Benesvosky, F. (ed.). Reutte/Tyrol, Austria; Metallwerk Plansee (1971).

From 7th Plansee seminar on powder metallurgy of high temperature materials; Reutte/Tyrol, Austria (21 Jun 1971). See CONF-710602-(Vol.4).

Studies were made on the effects of non-metal (mainly C) inclusions on different grades of cast tungsten. The results showed that alloying and a higher rate of cooling during crystallization affected the fine structure of W, making for the formation of the polygonal structure, i.e., for an increase in the density of dislocation in the metal, and especially in the proportion of screw dislocations. This in turn enhanced the effort exerted at spreading a crack in the case of a cleavage, thereby enhancing the resistance of the material to fracture by cleavage. (P.C.H.)

53682 INFLUENCE OF CARBON AND OXYGEN ON THE BRITTLENESS OF MOLYBDENUM. Touboul, J. P.; Minel, L.; Langeron, J. P. pp 1-18 of Proceedings of the 7th Plansee Seminar on Powder Metallurgy of High Temperature Materials. Vol. IV. /Benesvosky, F. (ed.). Reutte/Tyrol, Austria; Metallwerk Plansee (1971). (In French).

From seventh Plansee seminar on powder metallurgy of high temperature materials; Reutte/Tyrol, Austria (21 Jun 1971). See CONF-710602-(Vol.4).

Studies showed that it is possible to remove carbon from molybdenum by tempering at high temperature and under reduced oxygen pressure. Reaction kinetics is controlled by carbon diffusion in the metal. At high temperature, carbon and oxygen are present in a solid solution and lead to absorption layers on external surfaces and on internal grain surfaces. These layers can be recognized as surface striations. Carbon, dissolved in molybdenum at high temperature, precipitates during cooling predominantly on surfaces. The precipitate MO_2C appears as needles which are oriented in the dense crystallographic direction. At low temperatures, carbon precipitation on the external surface is less important than that on grain boundaries. Here, some precipitates can be detected at concentrations as low as 10^{-6}. (H.B.G.)

53683 CREEP BEHAVIOR OF FINE WIRES OF POWDER-METALLURGICAL PURE, DOPED, AND THORIATED TUNGSTEN. Moon, D. M.; Stickler, R. (Westinghouse Research Labs., Pittsburgh). pp 21.1-13 of Proceedings of the 7th Plansee Seminar on Powder Metallurgy of High Temperature Materials. Vol. IV. /Benesvosky, F. (ed.). Reutte/Tyrol, Austria; Metallwerk Plansee (1971).

From 7th Plansee seminar on powder metallurgy of high temperature materials; Reutte/Tyrol, Austria (21 Jun 1971). See CONF-710602-(Vol.4).

A technique to evaluate the high-temperature creep behavior of fine wires has been developed and applied to determine the creep properties of wires of pure, doped, and thoriated tungsten. The obtained data differ in some cases considerably from the creep data reported for large specimens of the same materials. The differences are explained by the fact that in recrystallized fine wires numerous grain boundaries traverse the entire specimen diameter, facilitating grain boundary sliding without the necessity of grain deformation such as required during creep deformation of large specimens. Fine dispersions of small bubbles in doped tungsten and of fine particles in the thoriated tungsten, which affect the recrystallized grain morphology and the retained dislocation substructure, were found to alter characteristically the creep behavior. (auth)

53684 ELECTRIC AND THERMAL CONDUCTIVITY, ELASTIC PROPERTIES, AND BENDING RESISTANCE OF POROUS TUNGSTEN OVER THE ENTIRE RANGE OF POROSITY. Francois, D. (CEA, Montrouge, France); Terraz, C.; Meyer, R.; Pastor, H. pp 22.1-14 of Proceedings of the 7th Plansee Seminar on Powder Metallurgy of High Temperature Materials. Vol. IV. /Benesvosky, F. (ed.). Reutte/Tyrol, Austria; Metallwerk Plansee (1971). (In French).

From seventh Plansee seminar on powder metallurgy of high temperature materials; Reutte/Tyrol, Austria (21 Jun 1971). See CONF-710602-(Vol. 4).

At a given porosity, variations in properties of tungsten powders are caused by texture and size of the different pores. Therefore, the degree of sintering is not the same. Even under identical sintering conditions, particle size of the powder differs. A mathematical equation for the degree of sintering is given. The various properties as affected by porosity are discussed. (H.B.G.)

53685 CLEAVAGE IN Ti–8Al–1Mo–1V CAUSED BY HYDROGEN GAS. Meyn, D. A. (Naval Research Lab., Washington, D. C. Met. Trans.; 3: No. 8, 2302-5(Aug 1972).

Studies were made on the hydrogen-embrittlement mechanisms proposed to explain cleavage in Ti–8Al–1Mo–1V caused by H gas. The results showed that crack propagation by gaseous H in Ti–8Al–1Mo–1V does not occur by the same mechanism as stress corrosion cracking, sustained load cracking, or low amplitude fatigue. Thus, either H is not directly causative in these latter cracking modes, or it somehow gives rise to different effects when supplied by other means to the crack tip than as a gas at the surface. (P.C.H.)

53686 NEW METASTABLE PHASE IN RAPIDLY SOLIDIFIED Al–Zr ALLOYS. Ohashi, T.; Ichikawa, R. (Nagoya Inst. of Tech., Japan). Met. Trans.; 3: No. 8, 2300-2(Aug 1972).

Studies were made on the crystal structure of the metastable Al_3Zr phase formed by rapid solidification of the molten Al–3 ~ 6 wt % Zr alloys. The results showed that the crystal structure was the same as that of the metastable precipitate from the supersaturated solid solutions that were obtained by rapid solidification of the molten Al–1 ~ 1.1 wt% Zr alloys. (P.C.H.)

53687 TRANSVERSE TENSILE PROPERTIES OF BORON FIBER REINFORCED ALUMINUM MATRIX COMPOSITES. Prewo, K. M.; Kreider, K. G. (United Aircraft Research Labs., East Hartford, Conn.). Met. Trans.; 3: No. 8, 2201-11(Aug 1972).

The transverse tensile properties of boron fiber reinforced aluminum have been determined as a function of fabrication parameters, matrix alloy and fiber types, fiber content, specimen geometry, and thermal environment. Matrix alloys investigated include 2024, 6061, 5052, 5056, 2219, 1100, and Al–7 pct Si. The fibers investigated include 4.0 mil boron, 4.2 mil BORSIC, R.F. boron, 5.6 mil boron, 5.7 mil BORSIC, and 4.0 mil silicon carbide. It was found that the composite transverse tensile performance is a function of all of these variables and that transverse strengths of up to 45,000 psi can be achieved by the choice of the proper combination of matrix, fiber type, and fabrication procedures. (auth)

53688 EFFECT OF OXYGEN ON TANTALUM–SODIUM COMPATIBILITY. Klueh, R. L. (Oak Ridge National Lab., Tenn.). Met. Trans.; 3: No. 8, 2145-50(Aug 1972).

The effects of oxygen in both phases on the compatibility of tantalum with sodium were investigated at 600°C by exposing tantalum specimens to liquid sodium in static capsules. Increasing the initial oxygen concentration of the sodium from 50 to 12,000 ppM led to increased dissolution of the tantalum in the sodium; oxygen migrated from the sodium to the tantalum. As the initial oxygen concentration of the sodium increased, the accompanying tantalum specimens first gained and then lost weight. It was concluded that the addition of oxygen to sodium results in the formation of a loosely adhering ternary oxide scale on the tantalum surface. The increased dissolution of tantalum and the weight change behavior of the tantalum specimens when the initial oxygen concentration of the sodium is increased indicated that the nonadherent ternary oxide flakes off in progressively greater amounts as its thickness increases. When the concentration of oxygen in tantalum before test exceeded 200 ppM, sodium penetrated the tantalum. Penetration, as in other refractory metal-oxygen-alkali metal systems previously investigated, proceeded with the formation of a ternary oxide by a wedging mechanism. At low oxygen concentrations attack occurred along grain boundaries, and as the oxygen concentration of the tantalum was increased, the number of grain boundaries attacked and the depth of attack increased. Still higher oxygen concentrations induced transgranular attack. (auth)

53689 EXPLORATORY INVESTIGATION OF Y, La, AND Hf COATINGS FOR NITRIDATION PROTECTION OF CHROMIUM ALLOYS. Stephens, Joseph R. (Lewis Research Center, Cleveland). Met. Trans.; 3: No. 8, 2075-86(Aug 1972).

Chromium alloys were coated with Y, La, and Hf, either singly or in combination, by pack cementation. Based on ductile-brittle transition temperature, a complex Cr + Y + La coating offered the most potential for protecting chromium alloys from nitrogen embrittlement. For example, the transition temperature for a chromium + 0.17 wt % Y substrate coated with this complex Cr + Y + La coating was 450°K after isothermal exposure in air at 1420°K for 200 h, compared to a transition temperature of 840°K for the similarly exposed uncoated substrate. Simple yttrium coatings were more attractive as coatings for chromium alloys than simple lanthanum and hafnium coatings. (auth)

53690 CYCLIC CREEP-RUPTURE BEHAVIOR OF THREE HIGH-TEMPERATURE ALLOYS. Halford, G. R. (Lewis Research Center, Cleveland). Met. Trans.; 3: No. 8, 2247-56 (Aug 1972).

Some important characteristics of the cyclic creep-rupture curves have been studied for the titanium alloy 6Al–2Sn–4Zr–2Mo at 900 and 1100°F, the cobalt-base alloy L-605 (Haynes 25 alloy) at 1180°F, and for two hardness levels of 316 stainless steel at 1300°F. Such curves have been used successfully in a previous investigation for the evaluation and prediction of strain-cycling life at elevated temperatures within the creep range. The cyclic creep-rupture curve relates tensile stress and tensile time-to-rupture for strain-limited cyclic loading and has been found to be independent of the total strain range and the level of compressive stress employed in the cyclic creep-rupture tests. The cyclic creep-rupture curve was always found to be above and to the right of the conventional (constant load) monotonic creep-rupture curve by factors ranging from 2 to 10 in time-to-rupture. This factor tends to be greatest when the creep ductility is large. Cyclic creep acceleration was observed in every cyclic creep-rupture test conducted. The phenomenon was most pronounced at the highest stress levels and when the tensile and compressive stresses were completely reversed. In general, creep rates were found to be lower in compression than in tension for equal true stresses. The differences, however, were strongly material dependent. (auth)

53691 LOW STRAIN TENSILE BEHAVIOR OF U–7.5 WT. PCT Nb–2.5 WT. PCT Zr. Albright, C. (Sandia Labs., Albuquerque, N. M.); Stein, C. Met. Trans.; 3: No. 8, 2217-23(Aug 1972).

The stress-strain response of polycrystalline, γ-quenched U–7.5 wt % Nb–2.5 wt % Zr alloy was studied as a function of strain rate and compared to equilibrium stress-strain tests performed by allowing the strain to reach a maximum value at incrementally increasing stresses. Equilibrium stress-strain tests were also performed on prestressed samples. Sheet tensile specimens were held at various states of strain in an x-ray diffractometer to determine crystal structural changes during deformation. Prestressed tensile bars were sectioned and examined metallographically and with the x-ray diffractometer. Two linear regions were observed in the equilibrium stress-strain tests: a low stress region with a slope of 5.3 to 5.5×10^6 psi, and a region above 40,000 psi with a slope of 3.3×10^6 psi. Finite strain rates tended to increase both slopes. The diffractometer experiments yielded plots of lattice parameter vs strain which showed a shift from a bcc structure of the γ_S phase, to a bct structure of the γ_0 phase between 1 and 3% deformation. It is postulated that this is a thermoelastic martensite transformation. A semiempirical equation was developed which describes the equilibrium stress-strain behavior of this alloy in terms of a stress induced phase transformation. (auth)

53692 INTERNAL FRICTION PEAKS DUE TO NITROGEN IN Nb–Zr ALLOYS. Heulin, B.; Geschier, R.; Vercaemer, C. (Ecole Nationale Superieure de Chimie, Strasbourg). Mem. Sci. Rev. Met.; 69: No. 4, 309-14(Apr 1972). (In French).

The internal friction spectra of Nb–Zr–N alloys were determined as a function of the nitrogen contents for two zirconium concentrations: 2.0 and 3.8 at.%. Analysis of these spectra revealed the existence of two principal peaks at temperatures much higher than the temperature corresponding to the Snoek peak of nitrogen in pure niobium. The interpretation of these results suggests that one of these peaks results from the interaction between nitrogen atoms and zirconium atoms and the other from interactions between nitrogen atoms and the zirconium doublets. (France)

53693 CRYSTAL ORIENTATION AND THE HARDNESS OF ZIRCONIUM. Sayar, A.; Lehr, M. P. (CNRS, Vitry-sur-Seine, France). Metaux (Corros.-Ind.); 47: No. 560, 121-42(Apr 1972). (In French).

Large α Zr crystals were examined and the nature and orientation of their faces investigated. The Vickers hardness with a 300 g load varied between 85 and 150 kg/mm^2 and the Vickers microhardness with an 80 g load varied between 100 and 180 kg/mm^2. The Vickers hardness increases as the crystallographic faces approach the (0001) planes. It is shown how this hardness anisotropy is related to the relaxation of the mechanical stresses due to the plastic deformation of the metal around the deformation produced by the tool. Slip and twinning deformation mechanisms compete with one another. (France)

Radiation Effects

Refer also to abstracts 53317, 54972, 54989, 54990, 55008, 55010, 55011, 55189, and 55190.

53694 (JAERI-Memo-3936) STUDIES OF FISSION PRODUCT RELEASE IN TLG-1 IN-PILE GAS LOOP. 3. MEASUREMENT OF SHORT-LIVED GASEOUS FISSION PRODUCTS. Kitahara, T.; Shirai, E.; Kaieda, K.; Toyoshima, N.; Kumagai, K.; Yamada, T.; Gotoh, H.; Yagi, H. (Japan Atomic Energy Research Inst., Tokyo). Feb 1970. (In Japanese). NTIS (U. S. Sales Only).

Fission-product release from a sheet of U–Al foil has been studied using an in-pile gas loop, TLG-1 (JRR-2). Gamma-ray spectra of released fission products were measured with Ge(Li) detectors located at the inlet piping of the gas-purification system. Over 30 full-energy peaks were detected in the energy range of 0 ~ 1.8 MeV, including short-lived gaseous fission products: ^{89}Kr (0.220, 0.586 and 1.533 MeV), ^{90}Kr (0.125, 0.245, 0.540, 1.125, 1.542 and 1.778 MeV), ^{137}Xe (0.456 MeV), ^{138}Xe (0.260 and 0.436 MeV) and ^{139}Xe (0.177, 0.220 and 0.297 MeV). The fractional fission-gas release (the ratio of released activity/produced activity) was obtained for the various isotopes,and was found to be independent of the respective decay constants, indicating that fission gas release from the specimen was mainly due to direct recoil. (auth)

53695 (NASA-TM-X-2440, pp 570-6) DESIGN CONSIDERATIONS AND TEST FACILITIES FOR ACCELERATED RADIATION EFFECTS TESTING. Price, William E.; Miller, Charles G.; Parker, Richard H. (California Inst. of Tech., Pasadena). Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

Test design parameters for accelerated dose rate radiation ef-

fects tests for spacecraft parts and subsystems used in long-term missions (years) are detailed. A facility for use in long-term accelerated and unaccelerated testing is described. (auth)

53696 (NASA-TM-X-2440, pp 595-602) IRRADIATION EFFECTS STUDIES OF NERVA MATERIALS. DeMastry, J. A.; Merrick, T. P. (Westinghouse Astronuclear Lab., Large, Pa.). Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

Several materials, beryllium, CuB, BATH (Al-24 v/o TiH_2–6 v/o B_4C) and A-286, were irradiated at cryogenic temperatures to neutron fluences between 10^{17} and 10^{19} n/cm^2 (E > 1.0 MeV). Tensile properties were determined over a temperature range to evaluate the effects of irradiation on the material properties. The expected radiation damage typical of other materials was observed, a general increase in strength and decrease in ductility. The effects at LN_2 temperature (140°R) were more pronounced since radioinduced defects were not annealed out at 140°R. Decreases in both strength and ductility of beryllium were noted at 140°R. Mechanical strength was generally recovered at temperatures as low as 406°R for 10 minute anneals. Thermal conductivity in beryllium was decreased by almost a factor of six at 1×10^{19} n/cm^2 (E > 1 MeV). Both Cu 12 v/o B and Cu 24 v/o B exhibited increases in strength and decreases in elongation due to irradiation. BATH showed an increase in mechanical strength after irradiation and testing at 140°R. The A-286 alloy underwent decreased ultimate strength and increased yield strength under the conditions studied. These were no significant changes in elongation at the temperatures studied. Comparison of test data from different reactors and the statistical techniques employed in this program are also reviewed. (auth)

53697 (NASA-TM-X-2440, pp 603-8) EFFECT OF CRYOGENIC IRRADIATION ON NERVA STRUCTURAL ALLOYS. Dixon, C. E.; Davidson, M. J.; Funk, C. W. (General Dynamics, Fort Worth, Tex.). Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

Several alloys (Hastelloy X, AISI 347, A-286 bolts, Inconel 718, Al 7039-T63, and Ti–5Al–2.5Sn ELI) were irradiated in liquid nitrogen (140°R) to neutron fluences between 10^{17} and 10^{19} nvt (E > 1.0 MeV). After irradiation, tensile properties were obtained in liquid nitrogen without permitting any warmup except for some specimens which were annealed at 540°R. The usual trend of radiation damage typical for materials irradiated at and above room temperature was observed, e.g., increase in strength and decrease in ductility. However, the damage at 140°R was greater because this temperature prevented the annealing of radioinduced defects which occur above 140°R. The results showed that the threshold for measurable mechanical property damage in these materials at 140°R was between 10^{16} and 10^{17} nvt (E > 1.0 MeV). Room temperature annealing of tensile properties was performed prior to testing some of the alloys. Al 7039-T63 recovered about half the damage incurred at the highest exposure while the other alloys recovered a smaller amount. Previous similar studies of Al 2219 showed almost complete recovery after annealing at room temperature. Aluminum components in the NERVA engine will be at temperatures above 140°R during its coast periods. Additional postradiation annealing studies are required to establish design properties after thermal cycling to various temperatures. (auth)

53698 (NRL-7446) EFFECT OF NEUTRON IRRADIATION ON FATIGUE CRACK PROPAGATION IN TYPES 304 AND 316 STAINLESS STEELS AT HIGH TEMPERATURE. Shahinian, P.; Watson, H. E.; Smith, H. H. (Naval Research Lab., Washington, D. C.). 8 May 1972. Contract AT(49-5)-2110. 18p.

The resistance of pre- and postirradiation AISI Types 304 and 316 stainless steels to fatigue crack propagation was determined at 800 and 1100°F (427 and 593°C) using the fracture mechanics approach. The effects of irradiation on the fatigue resistance of these steels were dependent upon test temperature and irradiation conditions. In general, irradiation degraded the fatigue resistance at 1100°F (593°C), but at 800°F (427°C) enhancement was also observed. In both steels irradiated in a thermal reactor to a neutron fluence of 1.8×10^{21} n/cm^2 for neutron energies >0.1 MeV, fatigue crack growth rates at 800°F (427°C) were lower than in the unirradiated steels for a given stress intensity factor range ΔK. However, at 1100°F (593°C) the effect was reversed and crack growth rates were higher in the irradiated steels. Irradiation in a fast reactor to a fluence of $\approx 1.2 \times 10^{22}$ n/cm^2 > 0.1 MeV caused fatigue crack growth rates at 800°F (427°C) to increase at low values of ΔK and decrease at high values of ΔK. At 1100°F (593°C) the crack growth rates in the irradiated steel were either the same as, or higher than, the unirradiated steel. The influence of irradiation on fatigue lives generally reflected the effects observed on crack growth rate. (auth)

53699 (RT/FI-(72)10) RADIATION DAMAGE IN SINTERED ALUMINA: AN E.P.R. STUDY. Galli, A. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 24 Mar 1972. 49p. Dep. NTIS (U. S. Sales Only).

The effects of γ and reactor irradiations on sintered alumina, as revealed by EPR spectra, were studied. The absorption lines can be divided into groups to be identified with as many paramagnetic centers. Further support was found for the different action of the neutrons and of the γ's. Saturation effects with doses are pointed out. The nature of the centers was analyzed in the light of results obtained in studies on α-Al_2O_3 monocrystals. Some particular interpretation is suggested, concerning the structure of the spectral lines and related inferences even in the field of optical absorption spectroscopy. Other possible effects are also mentioned. (auth)

53700 (SC-T-722540) X-RAY STUDY OF MOLYBDENUM AND NICKEL IRRADIATED WITH HELIUM IONS. Bykov, V. M.; Zdorovtseva, G. G.; Troyan, V. A.; Khaimovich, V. S. Translated for Sandia Labs., Albuquerque, N. Mex., from Ukr. Fiz. Zh. (Ukr. Ed.); 15: No. 1, 135-8(1970). 6p. Dep. NTIS.

Studies were made on the changes in the x-ray diffraction picture of polycrystalline molybdenum and nickel specimens caused by ion bombardment with 60-keV He^+ ions. The study revealed splitting of the Debye lines with reflection angles close to 90°, which may be associated with tetragonal distortion of the crystal lattice. This change in the form of the elementary cell may be due to ordering of the helium atoms in the metal lattice. On annealing these changes decreased, disappearing completely at a temperature of 400°C. (auth)

53701 (STU-70-419/U-350(Pt.1,1)) CHANGE OF STRUCTURE AND MECHANICAL PROPERTIES IN STAINLESS STEEL BY IRRADIATION. PART 1.1. METALLOGRAPHIC STUDY OF NEUTRON IRRADIATED AND UNIRRADIATED 12R72HV AFTER TENSILE TESTING. Lindhagen, P.; Westin, R.; Hellstrand, E. (Aktiebolaget Atomenergi, Studsvik (Sweden)). May 1971. 26p. (In Swedish). (AE-MF-204).

A metallographic study of neutron irradiated, as well as unirradiated, 12R72HV steel after tensile testing is described. Before testing, the steel has been resolving annealed at 1150°C as well as cold-worked to 15% and annealed at 830°C. It was shown that neutron irradiation lowers the ductility by tensile testing in the temperature range 500 to 800°C. Helium bubbles formed by plastic deformation prevented dislocation movements. It was established that there is only a slight grain deformation before crack. Comparison has been made with earlier observations after heat treatment at 1100°. The lowering of ductility according to irradiation is less in these earlier observations. This can be explained with smaller grain size, more favorable titanium carbide structure, and bigger helium bubbles. (Sweden)

53702 (TID-26150) DIFFUSIONAL GROWTH OF VOIDS INDUCED BY IRRADIATION AND STRESS. Wolfer, W. G. (Westinghouse Electric Corp., Madison, Pa. Advanced Reactor Div.). Dec 1971. Contract AT(11-1)-3045. 30p. Dep. NTIS.

An expression was derived for the growth rate of a spherical void in a metal subjected to irradiation and a triaxial stress system. The flow of vacancies and interstitials to the void was found to be affected by the stress field in two distinct ways. First, the diffusion coefficients for point defect migration were altered by the local hydrostatic stress. Second, and most important, the point defect concentrations in the vicinity of the void were changed. Although both mechanisms apply to interstitials and vacancies as well, only the vacancy flow to the void was considerably perturbed by the stresses. Thus, tensile stresses led to an enhanced void growth rate. It was found that this effect may substantially influence the radioinduced swelling in metals. (auth)

53703 EFFECT OF CREEP TEST TEMPERATURE ON CREEP RUPTURE PROPERTIES OF ALPHA-RAY IRRADIATED AISI 316 STAINLESS STEEL. Furuta, Teruo; Ogawa, Yutaka; Nagasaki, Ryukichi (Japan Atomic Energy Research Inst., Tokai). Tetsu To Hagane; 58: No. 8, 1117-25(Jul 1972). (In Japanese).

Since it is known that helium bubbles deteriorate the mechanical properties of stainless steel used as fuel cladding in fast-breeding reactors, the effect of helium was studied. Thin plate specimens of Type 316 stainless steel with helium content of 7.5×10^{-6} atom fraction that had been injected by α-ray irradiation from a cyclotron were creep-rupture tested at 550, 650 and 750°C. The presence of helium caused large reductions in rupture life and elongation as test temperature increased. The loss of ductility was shown to be constant at one test temperature. By observing fracture surfaces with optical and scanning electron

microscope, the difference between the specimen with or without containing helium was clear, and it was shown that the embrittling effect of helium resulted from its tendency to concentrate at grain boundaries, leading to intergranular cracking. (auth) (Japan)

53704 APPLICATION OF FIELD-ION MICROSCOPY IN STUDIES OF POINT DEFECTS AND RADIATION DAMAGE. Ralph, B.; Hudson, J. A. (Cambridge Univ., Eng.). pp 67-85 of Applications of Field-Ion Microscopy in Physical Metallurgy and Corrosion. /Hochman, R. F. (ed.). Atlanta; Georgia Inst. of Tech. (1969).

From Conference on applications of field-ion microscopy in physical metallurgy and corrosion; Atlanta, GA. (15 May 1968). See CONF-680570.

An account of the application of field-ion microscopy to the investigation of point defects and their clusters induced by irradiation is presented. A detailed examination of current ideas concerning the expected contrast from defects is given together with possible difficulties associated with the introduction of artefact defects which tend to demote the statistical significance of the results. Developments in technique are summarized together with a discussion of recent studies. (J.R.D.)

53705 YIELD STRESS RADIATION DAMAGE FUNCTION OF IRON. Odette, G. R.; Ziebold, T. O. (Massachusetts Inst. of Tech., Cambridge). Nucl. Sci. Eng.; 49: No. 1, 72-81(Sep 1972).

An experiment was performed to measure the energy-dependent damage function for the neutron irradiation induced increase in the lower yield strength of iron. Small tensile test specimens were exposed at low temperatures (<100°C) to 10^{17} to 10^{18} n/cm^2 (E > 1 MeV) in seven reactor spectra while a high degree of consistency among all other variables known to be significant was maintained. The neutron flux spectra in all locations were measured using the multiple foil activation technique and the SAND-II code for the data analysis. The mechanical property and flux spectral data were then analyzed using SAND-II to unfold the damage functions. Estimates of errors induced in the solution by the iterative unfolding procedure were made considering possible contributions from both the lack of mathematical solution uniqueness and data error propagation. (auth)

53706 EFFECT OF ELECTRON RADIATION ON THE MECHANICAL PROPERTIES OF Fe-Cr AND Fe-Mo ALLOYS. Bystrov, L. N.; Zhukova, L. P.; Platov, Yu. M. Fiz. Khim. Obrab. Mater.; No. 1, 19-22(1972). (In Russian).

The mechanical properties of Fe-15 or 20% Cr, and Fe-5% Mo were studied after exposure to 2.3 MeV electrons over the temperature interval 20 to 200°C, and in a dose of from 1 to 4.5×10^{18} cm^{-2}. Irradiation of the Fe-Cr alloys caused a decrease in the tensile strength, an increase in the yield point, and a drop in the relative elongation to rupture. These effects are associated with a deposit of the σ-phase as a result of intensified radiation-diffusion. Irradiation of Fe-Mo lead to analogous changes in its mechanical properties as a result of the appearance of an ϵ-phase. (tr-auth)

53707 DOSE DEPENDENCE OF SWELLING IN IRRADIATED METALS. Fisher, S. B.; Williams, K. R. (Central Electricity Generating Board, Berkeley, Eng.). Radiat. Eff.; 14: No. 3-4, 165-70(Jun 1972).

The dose and dose rate dependences of swelling were determined theoretically for metals under different types of irradiation. The simple theory assumes that it is the preferential absorption of interstitials by climbing dislocations that is directly responsible for the swelling. In particular, the different dose dependences observed under ion, electron, and neutron irradiation are explained in terms of the dislocation configurations operative in each case. (auth)

53708 HIGH FLUX IRRADIATIONS IN THE HVEM. Fisher, S. B. (Central Electricity Generating Board, Berkeley, Eng.). Radiat. Eff.; 14: No. 3-4, 171-4(Jun 1972).

The Hitachi HU-1000 and AEI EM7 high-voltage microscopes were used for high-flux (~10^{-2} d/a) irradiation experiments on the Nimonic alloy PE16. The advantages and problems associated with the use of the HVEM at this flux level are discussed in detail and a comparison between the two machines in respect of this type of study is made. (auth)

53709 THERMAL RELEASE OF HELIUM INJECTED INTO NICKEL, STAINLESS STEELS, AND NIMONIC PE16. Whitmell, D. S.; Nelson, R. S. (Atomic Energy Research Establishment, Harwell, Eng.). Radiat. Eff.; 14: No. 3-4, 249-55(Jun 1972).

The release of helium from nickel, 316 and 18/8 stainless steels, and Nimonic PE 16 foils uniformly filled with helium to concentrations of the order of 10^{-5} atom/atom was measured during linear-rise anneals and compared with the release from nickel foils implanted with low-energy helium ions. Annealing peaks were observed and attributed to radiation damage annealing, helium diffusion to form gas bubble nuclei, and gas release by bubble migration. The fraction of helium released was found to be concentration dependent and to be much smaller from stainless steels than from nickel. This was attributed to increased trapping. The activation energy for diffusion of helium in nickel was found to be 2.50 eV. In nickel annealed at 600°C all of the helium was incorporated in bubbles, which were predicted to be approximately 20 Å diameter. It was concluded that voids formed by ion bombardment to high doses at elevated temperatures in helium-filled foils were nucleated on these bubbles. (auth)

53710 EFFECT OF RESIDUAL ELEMENTS ON RADIATION STRENGTHENING IN IRON ALLOYS, PRESSURE VESSEL STEELS, AND WELDS. Smidt, F. A. Jr.; Watson, H. E. (Naval Research Lab., Washington, D. C.). Met. Trans.; 3: No. 8, 2065-73 (Aug 1972).

Embrittlement of pressure vessel steels and welds during irradiation at service temperatures around 290°C is known to be related to the presence of residual elements such as copper but the mechanism of embrittlement has not been clear. Pressure vessel steels and welds with high and low copper content and binary iron alloys with 0.3 at. % of Cu, V, Ni, and P and 0.1 at. % C were irradiated to fluences of 2.5×10^{19} and 4.5×10^{20} n/cm^2 <1 MeV and compression tested to determine the radiation strengthening. Alloys containing copper had more rapid and greater radiation strengthening. It was concluded that the embrittlement is due to this radiation strengthening which in turn results from a higher density of defect aggregates. Vacancy trapping by the copper atoms which modifies the kinetics of defect aggregate nucleation was found to be the most likely cause for the differences in microstructure. (auth)

53711 RECRYSTALLIZATION OF α PARTICLE IRRADIATED TUNGSTEN. Stepper, Heinz-J. (Westinghouse Lamp Divisions, Bloomfield, N. J.). Met. Trans.; 3: No. 8, 2293-4(Aug 1972).

Heavily deformed, pure powder metallurgy W ribbons were irradiated with high-energy α particles in order to investigate whether bubbles introduced by this method would affect the recrystallized grain size and the recrystallization temperature. The results showed that helium bubbles precipitate in a narrow band after postirradiation annealing of α particle irradiated W ribbons. As a consequence, recrystallization was retarded and the recrystallization temperature of the band containing helium bubbles was increased from 1300°C to approximately 2100°C. The precipitation of helium bubbles gave rise to a recrystallized grain structure, very much like that in doped W, with the long dimension of the grains oriented parallel to the working direction. (P.C.H.)

53712 STUDY OF POINT DEFECT INDUCED IN Al BY QUENCH HARDENING AND ELECTRON BOMBARDMENT. Brugiere, R.; Lucasson, P. (Univ., Paris). Mem. Sci. Rev. Met.; 69: No. 4, 277-84(Apr 1972). (In French).

Zone refined Al was quenched from temperatures between 260 and 370 to −196°C, subjected to irradiation at −160°C with 1.6 MeV electrons, or subjected to quenching and subsequently irradiated. The curve representing the increase in resistivity as a function of the incident electron flux presents a plateau for samples quenched from a high temperature and subsequently irradiated. In addition, a correlation is observed between this anomaly in the curve and the production of defects as a function of the electron flux and shape of the annealing isochrones. These phenomena are interpreted in terms of the interaction between point defects and impurities and are discussed for the different models for stage III of the recovery in electrical resistivity of the irradiated metal. (France)

Other Materials

Refer also to abstracts 53061, 53090, 53317, 53569, 53570, 53651, 54049, and 54991.

53713 (CEA-CONF-1894) IN PILE RADIATION DAMAGE IN GRAPHITE. CORRELATION BETWEEN TEMPERATURE AND FLUX DENSITY IN THE RANGE OF HIGH TEMPERATURE. Genthon, J. P.; Micaud, G. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1972. 3p. (In French). (CONF-720609-4). Dep. NTIS (U. S. Sales Only).

From International carbon conference; Baden-Baden, Germany (26 Jun 1972).

A series of in pile irradiation experiments with graphite confirm and define a model; this model is defined by a displacement zone structure of elementary defects induced by one neutron collision. It was concluded that monovacancies were not present but

the existence (possibly among others) of a defect of activation energy Q = 4 eV (which may be a divacancy) was confirmed. This value Q = 4 eV is suggested for the classic adjustment of equivalent temperature in the interval 600 to 1400°C. (auth)

53714 (NAA-SR-8533) STABILITY OF A LIGHT METAL HYDRIDE. Vetrano, J. B. (Atomics International, Canoga Park, Calif.). 1 Aug 1963. Contract AT-11-1-Gen-8. 25p. Dep. NTIS.

Declassified 25 Oct 1971.

The potential weight saving that could be made by using a certain light metal hydride as a neutron shield in a nuclear space-power system stimulated an investigation of its thermal stability. After an induction period, the compound was found to decompose irreversibly. The induction period was sufficiently short, and the decomposition sufficiently rapid, at 250°C, to make the material unsuitable for the intended application. The kinetics of the decomposition fit a second order autocatalytic rate expression. An x-ray diffraction analysis, a displacement density analysis, and a petrographic analysis were performed on the starting material. (auth)

53715 (NASA-TM-X-2440, pp 476-80) THERMODYNAMIC AND TRANSPORT PROPERTIES OF FROZEN AND REACTING pH_2–oH_2 MIXTURES. Carter, H. G.; Bullock, R. E. (General Dynamics Corp., Fort Worth, Tex.). Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

Application of experimental state data and spectroscopic term values shows that the thermodynamic and transport properties of reacting parahydrogen-orthohydrogen (pH_2-oH_2) mixtures are considerably different than those of chemically frozen pH_2 at temperatures below 300°R. Such differences will be significant from the standpoint of nuclear rocket design if it turns out that para- to orthohydrogen conversion can be catalyzed by radiation in the cold dense phase. Calculated H-S data also showed that radioinduced pH_2-oH_2 equilibration at constant enthalpy can produce a temperature drop of at least 28°R, corresponding to an ideal shaft work loss of 15% or more for a turbine operating downstream from the point of conversion. Aside from differences in thermodynamic and transport properties, frozen pH_2-oH_2 mixtures may differ from pure pH_2 on a purely hydrodynamical basis. (auth)

53716 POLYMERIZATION OF ADHESIVES UTILIZING HIGH-ENERGY RADIATION. Allen, James D. (North American Rockwell Corp., Tulsa, Okla.). pp IB.2.1-14 of Materials Review for '72. Azusa, Calif.; Society of Aerospace Material and Process Engineers (1972).

From seventeenth National SAMPE symposium and exhibit; Los Angeles, CA. (11 Apr 1972). See CONF-720437.

The results from a research and development investigation into the use of penetrating high-energy radiation for the rapid ambient temperature curing of adhesives are described. Utilization of cobalt-60 gamma rays and accelerated electrons, electron beams, to cure specially formulated radiation sensitive adhesive materials is described. Lap-shear adhesive strengths obtained on 2024T3 aluminum using cobalt-60 gamma rays and accelerated electrons for cure are reported. Variables such as the exposure, or dosage, required for cure are discussed as well as the room and elevated temperature adhesive strengths obtainable via radiation curing. Also described is the fabrication of flat aluminum sandwich panels using cobalt-60 and/or accelerated electrons to cure the adhesive layers. Methods of panel preparation, exposure times, and exposure rates are given. Flat panel production rates possible with the electron beams are discussed. Mechanical properties of some of the bonded aluminum sandwich panels, i.e., flatwise tensile and climbing drum peel have been determined and are reported. (auth)

53717 INTERPRETATION OF RADIATION EFFECTS ON MECHANICAL PROPERTIES OF CARBON FIBERS BASED ON A SHEATH AND CORE MODEL OF FIBER STRUCTURE. Bullock, R. E. (General Dynamics, Fort Worth, Tex.). J. Mater. Sci.; 7: No. 8, 964-7(Aug 1972).

Fast neutron irradiation in air has a considerable effect on the strength of HTS (high strength) carbon fiber and on the modulus for both HTS and HMS (high modulus) fibers, but very little effect on the strength of HMS fiber. The properties that are affected behave similarly, first rising with neutron fluence and then decreasing. Irradiations were also carried out in liquid nitrogen. An interpretation of the effects (and an explanation for the differences between HTS and HMS fibers) is proposed, based on a previously suggested "sheath" and "core" structure for the fiber. (UK)

53718 CHEMICAL REACTION RATE UNDER THE INFLUENCE OF A HIGH-ENERGY ELECTRON BEAM. Smiyan, O. D. Fiz. Khim. Obrab. Mater.; No. 1, 163(1972). (In Russian).

The catalytic effect of a high-energy electron beam on certain chemical reactions is discussed, e.g., the time of formation of CH^+ from C + H as a function of the energy of the bombarding electrons (from 30 to 45 keV). At 45 keV the formation of CH is practically instantaneous. (K.S.W.)

53719 ALKALINE HALIDES IN THE CARRIER DISTILLATION PROCESS IN U_3O_8 MATRIX. THERMOCHEMICAL REACTIONS HYPOTHESIS IN THE EVAPORATION MECHANISM. Boniforti, R.; Ciancia, A.; Di Giorgio, G. (Comitato Nazionale per l'Energia Nucleare, Casaccia, Italy). Spectrochim. Acta, Part B; 27: No. 7, 309-21(Jul 1972).

The action mechanism of the alkaline halides in the carrier distillation process was studied. From the temperature data in the anodic charge it was concluded that the alkaline carriers were melted, and a solvent action of the carrier salt on the oxide impurities contained in the U_3O_8 matrix was postulated. The possibility of some thermochemical reactions in the anodic cup was evaluated; the reaction products, formed during arcing, were identified by x-ray diffraction analysis. The x-ray diffraction data and the thermodynamic calculations generally are in rather good agreement. (auth)

53720 STUDY ON THE EFFECTS OF RADIATION ON THE MOLDING OF POLYMERS. Kimura, Hiroshi; Yamaguchi, Takuzi; Imachi, Masaki (Fukui Univ., Japan). Fukui Daigaku Kogakubu Kenkyu Hokoku; 19: No. 1, 45-51(Mar 1971).

An empirical study is presented of the effects of a ^{60}Co gamma radiation on molding of polyethylene with respect to cross-linking, where different irradiation conditions are employed. Results obtained were: (1) the elongation of molded materials decreases and becomes brittle with an increase of the quantity of radioactivity; (2) a rapid change of fluidity and molding can be found between 1×10^7 R and 5×10^7 R; (3) the quantity of radioactivity has a relatively slight effect on strength; (4) with an increase in the irradiation temperature, fluidity and molding decrease; (5) the effects of high-temperature irradiation is, if in water, much greater; and (6) it is possible to mold F.R.T.P.'s from the irradiated polyethylene that have great strength. (auth) (Japan)

53721 MELTING POINT DIAGRAMS FOR THE LiCl–UCl_3–UCl_4 SYSTEM. Desyatnik, V. N.; Kurbatov, N. N.; Raspopin, S. P.; Trifonov, I. I. At. Energ. (USSR); 32: No. 6, 479-80(Jun 1972). (In Russian).

The melting point behavior of the binary and ternary systems containing LiCl, UCl_3, and UCl_4 was studied. Two eutectics in the LiCl–UCl_4 system were detected at 31 and 44 mole% UCl_4 as well as the congruently-melting compound $2LiCl \cdot UCl_4$. A solid solution UCl_4–UCl_3, and eutectics corresponding to LiCl-40 mole% UCl_4–10 mole% UCl_3 and LiCl–19 mole% UCl_4–13 mole% UCl_3 were found. (K.S.W.)

53722 PROGRESS IN APPLICATION OF RADIATION TO THE CHEMICAL INDUSTRY. APPLICATION TO NEW COMPOSITE MATERIALS. Machi, Sueo (Japan Atomic Energy Research Inst., Takasaki). Sekiyu To Sekiyu Kagaku; 15: No. 8, 73-8(Jul 1971). (In Japanese).

The application of radiation to concrete-polymer composite materials, wood-plastic composite materials, glass fiber-reinforced plastics, and metal-plastic composite materials is reviewed. When composite materials are produced from several materials by reactions in a matrix after addition of reactive substances to the known matrix substances, radioactive processes are useful for such purposes as suppression of evaporation loss of low molecular weight substances and of strain that takes place at high temperatures, induction of uniform reactions in solid materials when γ rays are used, elimination of processes for addition and removal of catalysts, and attainment of high production rates by induction of reactions with electron accelerators in case of thin composite materials. Explanations are given on the change of various properties of composite materials by the irradiation. (Japan)

NUCLEAR MATERIALS AND WASTE MANAGEMENT

Accountability and Safeguards

Refer also to abstract 53306.

53723 DEVELOPMENT OF ON-LINE AUTOMATIC WEIGHING AND RECORDING SYSTEM FOR NUCLEAR FUEL MATERIAL. Kakimoto, Jiro (Furukawa Electric Co. Ltd., Tokyo). FAPIG (Tokyo): No. 63, 166-8(Nov 1971). (In Japanese).

A reliable automatic weighing and recording system was developed to control nuclear fuel material by weighing it in processing facilities. Inspection by official organizations required that the reliability of controlled data at main points of process lines is supported by physical measurements. The system was applied to the stack assembling process in a UO_2 pellet processing facility because this process gave the last chance to directly weigh the UO_2 quantity in the pellet processing line. The system consists of a continuous pellet transfer mechanism, a device for measuring length and weight, an operational and controlling means, and a recorder. Continuous operation was tested by circulating test pellets for about 250 h. A check of accuracy was carried out with standard sample every 50 h, and sufficient reliability was obtained to three significant digits. (Japan)

Disposal and Storage

Refer also to abstracts 53063, 53157, and 53261.

53724 (ORNL-TM-3815) PROPERTIES OF DRY CRUSHED SALT AND RELATED CONSOLIDATED MEDIA WITH EMPHASIS ON THEIR GAS TRANSPORT CHARACTERISTICS. Evans III, R. B.; Rutherford, J. L.; Truitt, J. (Oak Ridge National Lab., Tenn.). Sep 1972. Contract W-7405-eng-26. 123p. Dep. NTIS.

The gas-flow properties in dry and moist crushed salt beds were characterized. This study is related to the burial of packages of solidified radioactive waste, which generate heat, in salt mines using crushed salt as a back-fill material. Brine in bedded salt moves toward hot regions, releases water vapor, aids in waste package deterioration (possibly followed by activity release), and alters the back-fill properties. The first task was to determine whether dry back-fill would inhibit the flow of gases and aerosols of the type that might be released from a defective package. Experimental results, coupled with other considerations, indicate that unconsolidated salt does not constitute an effective barrier to gas-borne contaminants, even if their transport were diffusion controlled. No consideration was given to the filtering properties of the back-fill, however, and this may significantly inhibit aerosol transport. Next, the work was extended to the water vapor-air system using salt beds of fixed composition. Two experiments involved imposition of time-constant temperature profiles on the beds. Flow mechanisms were varied, but the results were identical with the exception of the time required to form a weak seal or bridge. The bridge resided at a position (temperature) determined by the source potential. Retention of 5g $H_2O(1)/in.^2$ bed cross section signals bridge formation. During moisture accumulation, brine-water reflux causes localized bridge formation through evaporative porosity reduction, and sacrificial void formation above the bridge. When temperatures were increased with time, the entire moisture region was forced up the bed, leaving dried out bridges and voids behind. The interval of dry consolidation was markedly increased. Effects of compressive forces, present in mines, were not included. Only in situ mine experiments will reveal true back-fill behavior. (auth)

53725 (ORNL-TM-3903) IMPLICATIONS OF THE AMERICAN SALT CORPORATION'S UNDERGROUND WORKINGS ON THE PROPOSED FEDERAL WASTE REPOSITORY AT LYONS, KANSAS. Lomenick, T. F. (Oak Ridge National Lab., Tenn.). Aug 1972. Contract W-7405-eng-26. 36p. Dep. NTIS.

A study of excavations in the rock salt deposit in the vicinity of Lyons, Kansas, where a site, which includes the abandoned Carey Salt Mine, has been considered for the location of a proposed Federal Repository for radioactive wastes. The effects of the nearby American Salt Corporation's workings on the development of this site were determined, with no insurmountable problems being observed. These excavations were considered to be an asset to the project, since they provide a nearby repository for the several million tons of unsalable salt that would be generated as a result of mining activities associated with the proposed repository. (T.D.)

53726 CREATION OF A COMMUNITY SYSTEM OF RADIOACTIVE WASTE DUMPS. Grison, Gaston. Euro-Spectra; 10: No. 3, 91-4(Sep 1971).

Forecasts of solid radioactive waste accumulations in Europe through the year 2000 are made. The importance of developing community storage sites for these wastes is discussed. These sites could be better supervised at a lower cost and would be in safer locations than would be possible if they were in individual countries. In some instances the distance that wastes would have to be transported would be shorter. In addition, some countries might not have suitable sites for waste repositories. (T.D.)

Handling Equipment and Procedures

Refer also to abstract 53735.

53727 (ANL/HFEF-1) CONCEPTUAL DESIGN FOR THE HANDLING AND REMOTE DISASSEMBLY OF THE FUEL ELEMENT FAILURE PROPAGATION LOOP AT THE HFEF. Hagmann, D. B.; Chilenskas, A. A. (Argonne National Lab., Ill. Argonne National Lab., Idaho Falls, Idaho). May 1972. Contract W-31-109-eng-38. 117p. Dep. NTIS.

The Hot Fuel Examination Facility (HFEF) was assigned the remote disassembly and examination of the Fuel Element Failure Propagation (FEFP) loops. These loops, containing bundles of fast-reactor fuel elements, will be irradiated in the Engineering Test Reactor to obtain information on failure propagation in this type of fuel. A detailed preliminary plan and procedure have been developed by the HFEF staff for handling, disassembling, and examining the irradiated loops. The concepts developed meet the functional criteria established by the FEFP Project in the System Design Description. The disassembly and examination will be performed in the HFEF/N main cell, which is large enough to accommodate a loop in the vertical position. The equipment to be added to HFEF/N for the handling of the FEFP loop will include a loop-insertion cell, support structures for the loop and test train, a tube heater, several cutting machines, and many disassembly and examination fixtures. (auth)

53728 (JAERI-Memo-4009) POST-IRRADIATION EXAMINATION FACILITY FOR Pu-FUELS. (Japan Atomic Energy Research Inst., Tokyo). May 1970. (In Japanese). NTIS (U. S. Sales Only).

The first post-irradiation examination facility of Japan, designed for metallurgical examination of plutonium bearing fuels, has been constructed in a hot laboratory. This cell is located in the extension line of the metallurgical testing cells for uranium fuels. It consists of γ shielding of 150 mm thick lead and a stainless steel alpha containment box which is of sturdy construction. A pair of master-slave manipulators with double-sleeve alpha sealing and a ball-socket manipulator are installed over the alpha box and on the front respectively. Radioactive specimens and other items are loaded into the alpha-box through the pass-in port, where radiation-resistant neoprene rings are fitted on the inner surface. An aluminum can is fixed tightly in it to maintain the airtightness of the alpha box. Main in-cell equipment consists of a NaK capsule opener, a diamond wheel cutting machine, an optical microscope, two mechanical polishers and a length-measurement apparatus. Each of the in-cell items is of comparatively simple construction for facilitating decontamination. Radioactive wastes originating within the alpha box are removed after being sealed in a p.v.c. bag through the pass-out port. Electrodes of a high-frequency heat-sealing apparatus and p.v.c. bag-isolating device are placed under the pass-out port. The operating philosophy and shielding do not permit the penetrating radiation dose rate to exceed 2 mR/h at the outer surface of cell wall. Under these conditions, irradiated nuclear fuels up to a level of 500 Ci are safely handled. Unnecessary flammable materials are excluded from the cell to keep the risk of fire to a minimum. Reaction of alcohol with NaK is carried out in a nitrogen atmosphere while the air intake is closed with a damper. Decontamination of in-cell equipment for repair or maintenance is performed in a separate glove box. (auth)

53729 (LA-DC-72-230) SAMPLE PREPARATION AND EQUIPMENT PROBLEMS ASSOCIATED WITH RE-CYCLED, PURIFIED ATMOSPHERES. Bender, John H. (Los Alamos Scientific Lab., N. Mex.). [nd]. 5p. (CONF-720911-1). Dep. NTIS.

From International Metallographic Society meeting; Denver, CO. (21 Sep 1972).

Sample preparation for metallography in hot cells equipped with a system to remove water and oxygen from re-cycled argon requires extreme care in the choice of lubricants and cleansing solvents. This care is necessary to prevent chemical reactions with the purification "bed" that produce by-products which attack the plumbing of the system. Etching solutions are also incompatible with purification systems but minimal amounts and quick disposal prevent serious attack. Polishers and grinders equipped with carbon brushes require changing to resin-bonded graphite/molybdenum disulfide brushes and ultrasonic cleaners have shown the need for high quality components in the generator circuitry. (auth)

53730 (NASA-TM-X-2440, pp 277-9) TELEOPERATORS FOR REMOTE OPERATIONS IN SPACE. Little, L. E.; DiLorenzo, F. L. (Aerojet Nuclear Systems Co., Sacramento, Calif.). Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

The primary objective of the remote nuclear teleoperator study program was to define in detail a program plan which would provide a qualified operational space teleoperator system by about 1980. The concept and philosophy presented provides a product considered to be an advanced teleoperator when compared to today's state-of-the-art. Previous studies have shown that an operational space teleoperator could be developed in two to three years, but such a teleoperator would contain today's technology and be considerably restricted in its capabilities. The teleoperator concept was formulated to meet NERVA requirements. This concept is considered preliminary, permitting flexibility during the development period and the time at which the total integrated space program is being defined. Considerable effort can be expended in the areas of subsystem development (e.g., actuators, sensors, communications, and controls) assuring a program of developed basic subsystems prior to final concept selection. The areas of propulsion, attitude control, and logistics can follow. The conclusions reached are discussed. (auth)

53731 (NASA-TM-X-2440, pp 280-90) TELEOPERATOR SYSTEMS FOR MANNED SPACE MISSIONS. Interian, Alfred. Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

Space teleoperator system applications in the Space Station/Space Shuttle Program, which is where the most immediate need exists and the potential return is greatest, are discussed. (P.C.H.)

53732 (WCAP-1615) SHOCK LOADING ANALYSIS OF CORE SUBASSEMBLY: APDA CORE. Schramm, R.; Widmer, T. F. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Dept.). Aug 1960. 26p. Dep. NTIS.

Values of bending stress and deflections are presented which are based on the maximum acceleration recorded in the shipping container drop tests, i.e., 24 G's. The sub-assembly wrapper tube, under impact, deflects 0.307 in. at the center and is subjected to 34,560 psi bending stress in the outer fibers. The fuel pins in an 11-grid core assembly are deflected a maximum of 0.006 in. with respect to the support grids. This deflection is a composite of pin deflection and grid tab deflection. The maximum bending stress in the pins is 2828 psi. Under impact, the support grid tabs are deflected 0.0033 in. for an 11-grid type "A" assembly. Data on deflections for other grid arrangements are included. The impact load on the most critical grid structural parts is 6% of the allowable load before buckling and develops 2310 psi stress at this cross-section. (auth)

53733 (WCAP-2999) CRITICALITY CONTROL PARAMETERS AND SUPPORTING CALCULATIONS FOR URANIUM BEARING NUCLEAR FUEL AT LOW ENRICHMENT. Lacey, P. G. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). Oct 1966. 88p.

Criticality control parameters applicable for safe handling of uranium bearing fuel in the form of powders, pellets, and rods for U-235 enrichments of 6.0 w/o or less are presented. Major emphasis is given to the oxide fuel form typical of that to be processed in the Westinghouse Core Manufacturing facility. Experimental data are used to validate the calculational procedures for critical systems, and the basis for presenting the safe parameters is discussed. (auth)

53734 MANIPULATORS: A SURVEY. Newman, N.; Tait, K. E. (Univ. of New South Wales, Kensington, Australia). Elec. Eng. Trans., Inst. Eng., Aust.; EE-8: No. 1, 1-8(Apr 1972).

An outline of some applications of manipulators is given together with an appreciation of developments in the areas of augmentative, facilitative, hostile environment, prosthetic and orthotic manipulators. Indications are given of possible extensions for the use of manipulators when technology permits the production of more versatile economic devices. (auth)

Transportation

53735 (ORO-651(Rev.3)) URANIUM HEXAFLUORIDE: HANDLING PROCEDURES AND CONTAINER CRITERIA. (Oak Ridge Operations Office (AEC), Tenn.). Aug 1972. 75p. Dep. NTIS.

Revised handling procedures and container design and utilization criteria are presented for transactions involving the receipt or shipment of UF_6 by AEC. Topics covered are UF_6 weighing, sampling, cylinder emptying and filling, and cylinder inspection, cleaning, testing, and repair. Analytical and shipping procedures are discussed in general terms. Standard cylinder information, UF_6 properties, and safety considerations are presented as appendixes. (T.D.)

53736 (SC-DR-720597) SPECIAL TESTS FOR PLUTONIUM SHIPPING CONTAINERS 6M, SP5795, AND L-10. Stravasnik, L. F. (Sandia Labs., Albuquerque, N. Mex.). Sep 1972. 72p. Dep. NTIS.

The results of three extra-severe environments imposed on three plutonium shipping containers are summarized. (auth)

53737 STEEL-BANDED WOODEN SHIPPING CONTAINERS (29 Feb 1972) (Engineering Materials). (National Lead Co. of Ohio, Cincinnati). (CAPE-2259).

10 drawings.

A steel-banded wooden shipping container is described. The container has been approved by the AEC and the Department of Transportation for Fissile Class III shipments of uranium metal billets, ingots, and fuel cores, slightly enriched in ^{235}U. Two general types of wooden containers are used; boxes with lids, which are used primarily for fuel cores and pallets with covers used for billets and ingots. There is no chemical, galvanic, or other reaction between the U metal and wood but when pieces with a machined surface are shipped an Al foil liner is used to protect the surface. The containers are shipped in a closed, exclusive use trailer or railcar with a tamper-proof seal attached. (For details see TID-4100 Suppl. 72). (F.S.)

PARTICLE ACCELERATORS

Design, Development, and Operation

Refer also to abstract 53755.

53738 (FOA-4-4490-A-3) GAMMA RADIATION DOSE RATE IN THE SURROUNDINGS OF THE ELECTRON ACCELERATOR FX-45 AT URSVIK. Lefvert, Tomas; Persson, Marjorie (Forsvarets Forskningsanstalt, Stockholm (Sweden)). Apr 1972. 13p. (In Swedish). Dep. NTIS (U. S. Sales Only).

In order to investigate the possibilities of running the electron accelerator FX-45 at Ursvik with increased current, the gamma radiation dose rate in the surroundings of the accelerator has been calculated using a Monte-Carlo method. (Sweden)

53739 (LA-4874, pp 16-20) STATUS OF LAMPF. Rosen, Louis (Los Alamos Scientific Lab., N. Mex.). Mar 1972.

From fifth LAMPF users meeting; Los Alamos, NM. (8 Nov 1971).

Topics include the importance of LAMPF in the national and international scientific enterprise; construction progress on buildings, site, and services; accelerator construction status; R&D budgets and their implications; and user participation. (W.H.K.)

53740 (LA-4874, pp 21-33) WILL MEDIUM ENERGY PHYSICS FLY OR DIE? Kolstad, George A. (Division of Research (AEC), Washington, D. C.). Mar 1972.

From fifth LAMPF users meeting; Los Alamos, NM. (8 Nov 1971).

The cultural, economic and social, and educational or structural reasons for the support of medium energy physics research are discussed. Also, medium energy physics research history and funding are discussed. Sources of funding including government-wide funding levels and AEC funding are outlined. (W.H.K.)

53741 (NP-19416) ANNUAL REPORT, 1971. Brearley, N. (ed.) (TRI-Univ. Meson Facility, Vancouver (British Columbia)). May 1972. 58p. Dep. NTIS (U. S. Sales Only).

The cyclotron erection; construction; cyclotron design and engineering; safety, shielding, and activation; central region cyclotron model, project management and scheduling; and the experimental program are discussed. Also, reports from users groups, organizations and committees, conferences, reports and publications, staff, and a financial statement are given. (W.H.K.)

53742 STRAHLENSCHUTZ AN HOCHENERGIEBESCHLEUNIGERN. (Radiation Protection at High-Energy Accelerators). Freytag, Eberhard. Karlsruhe, Ger.; G. Braun (1972). 127p.

Topics include high-energy acceleration, interactions of particles with matter, interactions of photons with matter, hadron cascades, electron-photon cascade, dose and dose equivalents, survey instruments for radiation protection at high-energy accelerators, shielding, activation, radiation damage in accelerator materials, dead-man's-handle, and space travel. (W.H.K.)

53743 EFFECT OF THE MAGNETIC FIELD ON A CLOSED-ELECTRON-DRIFT ACCELERATOR. Morozov, A. I.; Esipchuk, Yu. V.; Kapulkin, A. M.; Nevrovskii, V. A.; Smirnov, V. A. Sov. Phys.-Tech. Phys. (Engl. Transl.); 17: No. 3, 482-7(Sep 1972).

Translated from Zh. Tekh. Fiz.; 42: No. 3, 612-19(Mar 1972).

Measurements were made to elucidate the effect of the magnetic field configuration in the coaxial channel on the volt-amp characteristics and variation of the potential in the system. It was found that the discharge condition in the accelerator and the nature of the oscillations in the potential depend on the variation in the radial component of the magnetic field along the channel. In a magnetic field with a negative gradient, a strong azimuthal wave m = 1 is excited, and the electron current through the system increases several times. (6 figures) (R.W.R.)

53744 FIELD DISTRIBUTION, POWER LOSSES, AND PARAMETER OPTIMIZATION OF HELICAL ACCELERATOR STRUCTURES. Klein, H.; Merz, N.; Siart, O. (Univ., Frankfurt am Main). Particle Accel.; 3: No. 4, 235-44(Aug 1972).

A method for the parameter optimization of a helix accelerator providing minimum total power losses is given. Approximate calculations of surface charge and current distribution on helical waveguides and their application to the problem of power losses and maximum field strengths are reported. Perturbation measurements of axial and surface fields in helix resonators were made and compared with theoretical results. (10 figures, 2 tables) (auth)

53745 CERN PROTON SYNCHROTRON PROJECT (40 METERS UNDERGROUND). Anthoine, Roger (CERN, Geneva). Rev. Fr. Elec.; 45: No. 236, 43-7(1972). (In French).

The underground proton synchrotron envisaged by CERN, and due to be completed in 8 years time, is presented. The essential elements of the accelerator are described: the quasi-circular ring, which forms the vacuum enclosure in which the particles are accelerated, the accelerating equipment, the electromagnet which guides the particles in the evacuated enclosure, the cooling system, the computerized control system, and the experimental areas. (France)

Auxiliaries and Components

Refer also to abstract 53258.

53746 (RISO-M-1518) IMPROVING THE MATCH BETWEEN THE MICROWAVE SOURCE AND THE MICROWAVE TRANSMISSION SYSTEM AT THE RISOE 10 MeV ELECTRON LINEAR ACCELERATOR. Fenger, Joergen; Hansen, Johnny (Danish Atomic Energy Commission, Risoe. Research Establishment). Jul 1972. 31p. Dep. NTIS (U. S. Sales Only).

To achieve tolerable load conditions for the high-power microwave source at the 10 MeV linear accelerator, comprehensive measurements of various parameters in the accelerator tubes and the waveguide system were carried out. Based on the measurements a modification of the parameter-defining linac components has improved the present performance and caused a higher overall efficiency. (auth)

53747 (SC-DR-720447) FEASIBILITY OF USING THE FARADAY EFFECT TO MEASURE CURRENTS IN THE ELECTRON BEAM ENVIRONMENT. McArthur, David A. (Sandia Labs., Albuquerque, N. Mex.). Aug 1972. 42p. Dep. NTIS.

Optical analogues of the integrating $\partial B/\partial t$ probe and the integrating Rogowski coil have been successfully developed for use in the environment of the intense relativistic electron beam. Under normal operating conditions these optical current monitors do not require an almost-closed electrostatic shield, and no signal cables are connected to the machine; therefore, this type of current monitor should be free from much of the noise and ringing which is seen on some current monitors used with electron beam machines. The experimental techniques used, comparison between the signals from the optical monitor and an integrating Rogowski coil, comparison between theory and experiment for the optical monitor sensitivity, and elimination of some spurious effects which were observed are described. The response time of the present optical system is limited by the photomultiplier to $\tau = 5$ nsec, but this can probably be decreased to $\tau \lesssim 1$ nsec, by using a better photomultiplier. (auth)

53748 SURFACE CONDITION OF NIOBIUM FOR SUPERCONDUCTING RF CAVITIES. Strongin, M. (Brookhaven National Lab., Upton, N. Y.); Farrell, H. H.; Halama, H. J.; (and others). Particle Accel.; 3: No. 4, 209-23(Aug 1972).

In recent years superconducting rf cavities with extremely small losses have become important for linear electron accelerators and rf beam separators. Niobium appears to be the most favorable metal for these devices; however, the rf field at which "breakdown" to the normal state occurs is much lower than expected, and it is probable that this effect is related to the surface condition of the niobium. Previous work in this area is reviewed, and additional measurements are presented. Low-energy electron diffraction measurements of surface oxides were made, and Auger spectroscopy was used to study the amount of surface impurities. The Auger results show that, upon cooling niobium from high-temperature treatments, significant amounts of oxygen migrate to the surface. A simple calculation was made for how surface impurities can influence the value of the "breakdown" fields, and some ways of protecting the niobium surface with high-T_c superconductors are also discussed. (9 figures, 6 tables) (auth)

53749 DESIGN OF THE CYCLOTRON MAGNET FOR TRIUMF. Kiesners, U. (Dilworth, Secord, Meagher, and Associates, Ltd., Toronto). Eng. J. (Montreal); 55: No. 6, 18-24(Jun 1972).

The TRIUMF H^- Cyclotron will produce intense beams of mesons

and protons having a maximum energy of 500 MeV at maximum beam current 100 μA. To do this requires a very large magnet, consisting of six spiral sectors, whose combined size will be approximately 850 inches diameter and the total weight of over 4,000 tons. The magnet profile was determined from twentieth-scale-model studies. The mechanical design involved investigations of material availability, effect of chemical composition and micro structure on magnetic properties, limitations of Canadian manufacturing capabilities, transportation and handling capacities. Alternative concepts were compared and evaluated on performance, cost, and overall cyclotron arrangement. Davie Shipbuilding was awarded the construction contract from five Canadian bidders. Three-inch plates were supplied by STELCO; and heavier plates, by Lukens Steel Co. The cost of material, construction, and shop assembly was over $3,000,000. (auth)

53750 TESTS ON SUPERCONDUCTING HELIX RESONATORS. Benaroya, R.; Jaffey, A. H.; Johnson, K.; (and others) (Argonne National Lab., Ill.). Appl. Phys. Lett.; 21: No. 5, 235-6(1 Sep 1972).

A niobium helix-resonator cavity close to the frequency suitable for a heavy-ion accelerator was subject to an 8-week test, including 323 h at full power (axial electric field $E_{ax} > 2.5$ MV/m). The cavity, with an anodically deposited protective film of Nb_2O_5, had a high Q and supported high fields without deterioration over the whole period during which it was subject to a moderate internally generated x-ray dose. Properties were found to be stable against considerable thermal cycling and exposure to air. Measurement of emitted x-ray maximum energy allowed an independent corroboration of the field measurement calibration. (auth)

Ion Sources, Injection, and Extraction

Refer also to abstract 54976.

53751 (BNL-tr-498) POWER SUPPLY SYSTEM FOR THE PREINJECTOR OF THE I-100 LINEAR ACCELERATOR. Mal'tsev, I. G. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Institut Fiziki Vysokikh Energii). Translated by S. J. Amoretty (Brookhaven National Lab., Upton, N. Y.), from report IFVE-71-83. 11p. Dep. NTIS.

The semiconductor power supply system for a duoplasmatron-type ion source with pulsed admission of gas, which works in conjunction with the preinjector of the I-100 linac, is described. (W.H.K.)

53752 (FRNC-CONF-54) PRODUCTION OF Ca AND Ge IONS IN A PIG SOURCE. Malard, M.; Steinegger, A. (Paris Univ., Orsay (France). Institut de Physique Nucleaire). 1972. 5p. (In French). (CONF-720120-11). Dep. NTIS (U. S. Sales Only).

From Conference on the sources of multicharged ions; Paris, France (28 Jan 1972).

A PIG hot-cathode source equipped with an oven and utilizing solid elements (Ca, Ge, Zn) was studied. The dependence of the production of multiply charged gas ions on the temperature of the arc chamber was examined. The gas selected for the test was Kr, and the 8^+ charged ion was studied. The results obtained are briefly listed. (France)

53753 (FRNC-CONF-56) HEAVY ION SOURCE WITH A CONFINED ELECTRON BEAM. Arianer, J.; Baixas, J.; Baron, E.; Liebe, A.; Serafini, A.; Ton-That, T. (Paris Univ., Orsay (France). Institut de Physique Nucleaire). 1972. 6p. (In French). (CONF-720120-7). Dep. NTIS (U. S. Sales Only).

From Conference on the sources of multicharged ions; Paris, France (29 Jan 1972).

The construction of a source of the EBIS type (the SILFEC source) is in progress; the experimental unit is described. A program was developed for computing the ion and electron trajectories. Experiments for optimizing the various parameters of the source (electron guns, cathode) are described. (France)

53754 (JINR-E9-6538) PROTON BEAM EXTRACTION FROM THE 10-GeV DUBNA SYNCHROPHASOTRON BY EXCITING THE RESONANCE $Q_R = 2/3$ (FURTHER ANALYTICAL CONSIDERATIONS). Conte, Mario (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1972. 16p. Dep. NTIS (U. S. Sales Only).

The proposed scheme of ejection from the 10 GeV Dubna SPT via 2/3 nonlinear resonance is further investigated, mainly by analytical considerations. Checks between these results and others obtained by computer are presented. A method for minimizing the emittance of the extracted beam is suggested. (auth)

53755 (LBL-644) HEAVY ION ACCELERATION AT THE BERKELEY 88-INCH CYCLOTRON. Clark, D. J.; Steyaert, J.; Bowen, J.; Carneiro, A.; Morris, D. (California Univ., Berkeley. Lawrence Berkeley Lab.). Jun 1972. Contract W-7405-eng-48. 8p. (CONF-720717-6). Dep. NTIS.

From sixth international cyclotron conference; Vancouver, B. C. (18 Jul 1972).

A new internal heavy-ion source of the Penning type has been in operation at the Berkeley 88-Inch Cyclotron for 10 months. Beams of lithium, carbon, nitrogen, oxygen, neon, and iron have been accelerated and used in experiments in the energy range 4 to 18 MeV/nucleon. External beam intensities are 1 to 10 μA of most carbon, nitrogen, and oxygen beams. Many experiments have used the new high-resolution reaction product magnetic spectrometer and resistive wire focal plane detector. (6 figures, 1 table) (auth)

53756 (LBL-654) CYCLOTRON INJECTION SYSTEMS. Clark, D. J. (California Univ., Berkeley. Lawrence Berkeley Lab.). Jun 1972. Contract W-7405-eng-48. 12p. (CONF-720717-5). Dep. NTIS.

From sixth international cyclotron conference; Vancouver, B. C. (18 Jul 1972).

A review is given of the various methods which have been used for injecting beams into cyclotrons from external ion sources. The methods of injection include neutral beam, radial ion, and axial ion systems. The performance of presently operating systems is tabulated. Larger separated sector machines now under construction or proposed will use radial ion systems. (32 references) (auth)

53757 SELF-CONSISTENT STATIONARY STATE OF A RELATIVISTIC ELECTRON BEAM IN A DRIFT SPACE. Voronin, V. S.; Zozulya, Yu. T.; Lebedev, A. N. (Lebedev Inst. of Physics, Moscow). Sov. Phys.-Tech. Phys. (Engl. Transl.); 17: No. 3, 432-6(Sep 1972).

Translated from Zh. Tekh. Fiz.; 42: No. 3, 546-52(Mar 1972).

The stationary motion of a relativistic electron beam in the self-consistent potential field is investigated. The theoretical importance of a two-dimensional field geometry at the entrance to the drift space is demonstrated for large currents. A stationary state is obtained for a magnetized beam of arbitrary intensity in a semi-infinite tube. In this state, the equilibrium distribution of the current over the cross section is highly inhomogeneous. (auth)

53758 INFLUENCE OF INJECTION CONDITIONS ON THE TRANSVERSE INSTABILITY OF THE BEAM IN A LINEAR ACCELERATOR. Kramskoi, G. D.; Zykov, A. I.; Grishaev, I. A.; Fursov, G. L. (Physical-Technical Inst., Kharkov). Sov. Phys.-Tech. Phys. (Engl. Transl.); 17: No. 3, 437-40 (Sep 1972).

Translated from Zh. Tekh. Fiz.; 42: No. 3, 553-7(Mar 1972).

The influence of the diameter of the beam injected into an accelerating waveguide is investigated, and the influence of its displacement relative to the waveguide axis on the development of a transverse instability is examined. (auth)

Ion Optics and Field Calculations

Refer also to abstract 53770.

53759 FIELD DISTRIBUTION IN SUPERCONDUCTING LENSES WITHOUT FERROMAGNETIC MATERIALS. Dietrich, I.; Koller, A.; Lefranc, G. (Siemens AG, Munich). Optik; 35: No. 4, 468-78(Jun 1972). (In German).

The field distribution in a superconducting shielding lens and a ring lens is calculated numerically assuming a Kim–Anderson current distribution in the superconductor. The course of field on the optical axis is compared with the experiment. The measured and the calculated values agree well. Characteristic lens data are reported for certain measured field curves. (auth)

53760 EMITTANCE MEASUREMENTS AND DESIGN OF AN ION BEAM TRANSPORTING SYSTEM. Bakewicz, Edmund; Rogalska, Zofia (Inst. of Nuclear Physics, Krakow). Nukleonika; 117: No. 3-4, 145-56(1972).

The properties of the alpha-particle beam extracted from the Cracow cyclotron U-120, at an energy of 25 MeV and with a total beam current of 10 μA, were determined. A beam transport system, serving the five experimental positions, was designed. (6 figures) (auth)

53761 FREQUENCY SHIFT OF AXIAL OSCILLATIONS UNDER THE EFFECT OF THE BEAM SPACE CHARGE. Glazov, A. A.; Dzhelepov, V. P.; Dmitrievskii, V. P.; (and others) (Joint

Inst. of Nuclear Research, Dubna, USSR). Particle Accel.; 3: No. 4, 231-4(Aug 1972).

Experimental studies of the frequency shift of incoherent axial oscillations under the effect of the beam space charge in the electron model of the circular cyclotron are described. The results of the studies are in satisfactory agreement with the existing presentation on the mechanism of this shift. (3 figures) (auth)

53762 ACCELERATION OF POLARIZED PROTONS IN SATURNE. Faure, J.; Hilaire, A.; Vienet, R. (CEN, Saclay, France). Particle Accel.; 3: No. 4, 225-30(Aug 1972). (In French).

The possibility of preserving the polarization of protons in Saturne during the acceleration process is demonstrated. The main resonances are crossed when the spin frequency precession is equal to the frequency of the magnet field error as seen by the particles. The way to overcome the difficulty consists in a complete adiabatic reversal of the polarization for each resonance crossing. (4 figures) (auth)

53763 PART I. NONLINEAR BETATRON OSCILLATIONS. PART II. PARTICLE MOTION IN MUON g-2 EXPERIMENT. Lysenko, Walter Paul. New Haven; Yale Univ. (1972). 177p. University Microfilms Order No. 72-22,397.

Thesis.

PART I: Single particle motion in two dimensions for a nearly linear, nearly periodic system is studied by considering a set of perturbed Hill's equations. A transformation of variables is effected which permits the application of the Krylov–Bogoliubov averaging method. It is shown how this asymptotic perturbation technique can be used to all orders in the perturbation parameter for the nearly periodic resonance situation. The remainder of the work is a specialization to the case of a single resonance in the first approximation. The fourth-order system of equations is reduced to a second order system which describes the amplitude behavior for either the sum or the corresponding difference resonance. By making an approximation consistent with small relative variations in the amplitudes, explicit solutions are obtained for the betatron amplitudes as functions of the independent variable. Four cases are studied in which the operating point is fixed, moves parallel to a resonance line, crosses a resonance line, or passes close by a resonance line.

PART II: The orbit and spin motion in a muon g-2 experiment is studied. The aim is to determine the errors involved in the 10–20 ppm experiment proposed by V. W. Hughes to be run at LAMPF. This experiment involves a 1 m superconducting storage ring for p = 600 MeV/c muons. Weak magnetic focussing is used and electric quadrupoles electrodes maintain the precession frequency independent of radius. By studying the uncertainties in the various corrections to the precession motion, it is shown that a magnetic field decreasing linearly with the radius is desirable. An estimate of the particle losses by betatron resonances is made with the conclusion again that a linearly varying field of high accuracy is essential. In order to obtain a complete error analysis, other aspects of the experiment such as muon storage rates are also considered. (Diss. Abstr. Int., B)

53764 CHANGE IN BEAM SPOT SIZE DUE TO SECOND-ORDER EFFECTS IN A FIRST-ORDER ACHROMATIC BEAM TRANSPORT SYSTEM. Lobb, D. E. (Univ. of Victoria, B. C.). Nucl. Instrum. Methods; 103: No. 2, 271-5(1972).

A method is presented for determining which second-order terms have the greatest effect on a particle trajectory and which trajectories are so affected. A method is presented for calculating the maximum value of a position coordinate when second-order chromatic effects are present in a first-order achromatic system. (1 figure, 1 table) (auth)

Storage Rings

Refer also to abstracts 54181, 54182, 54200, and 54284.

53765 (BNL–16816) MAGNET FAULT PROTECTION: ISABELLE. Cottingham, J. G. (Brookhaven National Lab., Upton, N. Y.). 22 Dec 1971. 5p. Dep. NTIS.

An external power diode or a series of such diodes connected across the magnet leads to a dewar system will prevent the energy stored in the total magnet system of ISABELLE from feeding energy into a magnet that has failed. But it cannot remove energy from within the dewar containing the fault. Conditions immediately following a failure are discussed. The magnet terminal voltage reaches 700 V; this can be reduced, however, by connecting a shunt resistor across each magnet. The undesirable side effects of this resistor can be removed by inserting a series diode. (2 figures) (R.W.R.)

53766 (BNL–16818) ISABELLE FOR VERY LOW ENERGY $\bar{p}p$ EXPERIMENTS: WHIPLASH. Kalogeropoulos, T. (Brookhaven National Lab., Upton, N. Y.). 12 Nov 1971. 9p. Dep. NTIS.

The desirability of doing experiments with antinucleons at low energies (~15 MeV cms energy) and associated problems are discussed. It it suggested that experiments involving $\bar{p}p$ collisions between beams running in the same direction have significant advantages over those involving a stationary target. The kinematics of such experiments are considered, and some flux estimates are given. The possibility for obtaining a 200-GeV protonium beam is mentioned. (R.W.R.)

53767 (BNL–16830) SOME SPECULATIONS ON COLLIDING BEAMS OF 200 GeV PROTONS AND 15 GeV ELECTRON–200 GeV PROTONS. Yang, Chen Ning (Brookhaven National Lab., Upton, N. Y.). 31 Jan 1972. 5p. Dep. NTIS.

Although the ISR and NAL machines might produce results at variance with all elementary particle models yet proposed, it is more likely that they will verify the limiting behavior of high-energy collisions. Colliding beam proton–proton machines are needed to investigate slow dependences of theoretical formulations on incoming energy. Colliding beam electron–proton machines have the advantage that the electromagnetic interaction is known, but they can not substitute for a p–p machine. Colliding beam proton–antiproton machines are probably not needed, however, due to the similarity of pp and $\bar{p}p$ interactions. (R.W.R.)

53768 (BNL–16980) COIL CONFIGURATIONS IN SUPERCONDUCTING QUADRUPOLES. Parzen, G.; Jellett, K. (Brookhaven National Lab., Upton, N. Y.). 23 Jun 1972. 9p. Dep. NTIS.

The limitations on the good field aperture of superconducting quadrupoles due to approximating the cos 2θ current distribution by using a finite number of ribbon-shaped conductors arranged in blocks are investigated. Results are presented for three ribbon configurations having 2 and 3 blocks per octant, for which the lower undesired multipoles are eliminated by slight azimuthal displacement of the block. For the ISABELLE storage rings, 2 blocks per octant may be sufficient. Results are presented for the good field aperture limit due to the choice of the number of blocks per octant. (4 figures, 1 table). (auth)

53769 (BNL–16996) DETERMINATION OF LUMINOSITY USING THE INTERSECTION OF A HIGH β WITH A LOW β SECTION. Palmer, R. B. (Brookhaven National Lab., Upton, N. Y.). 29 Jun 1972. 3p. Dep. NTIS.

If the luminosity of any special region is known, as well as the rate for any arbitrary reaction measured in that region, then the luminosity at any other region can be established by a measurement of that same rate. There is proposed, therefore, a special crossing whose luminosity is low but whose characteristics make an exact determination of luminosity relatively easy. Specifically, the proposal calls for the intersection of two beams, one with low β and the other with high β, at a finite crossing angle. For reasonable assumptions, a luminosity of 6.5×10^{30} is found; while not great, this is acceptable for the determination of total cross section and elastic scattering at medium angles. It is concluded that errors in current measurement could be made negligible and that the method could give luminosities to the order of 0.3% accuracy. (1 figure) (R.W.R.)

53770 (BNL–17016) BETATRON FREQUENCY SHIFTS DUE TO IMAGE FIELDS. Gluckstern, Robert L. (Brookhaven National Lab., Upton, N. Y.). 30 Jun 1972. 7p. Dep. NTIS.

The variation of betatron frequency across a beam due to image fields is calculated for both circular and plane-parallel beam pipes. An approximate interpolated expression is then constructed which agrees with both limits and with the result for a slightly elliptical pipe. The effect appears to be more serious for the ISR than for the design parameters of the ISA. (auth)

53771 (BNL–17019) LUMINOSITY MEASUREMENTS FOR COLLIDING BEAMS. Marx, Jay N. (Brookhaven National Lab., Upton, N. Y.). 1972. 14p. Dep. NTIS.

Many experiments with colliding beam facilities require rather precise measurements of the luminosity; indeed, such a measurement may be the limiting factor for a given experiment. These experiments are of two general types, those that measure absolute reaction rates and those that require relative luminosity measurements in order to normalize a series of runs. Two approaches to the problem of measurement of beam luminosity are considered: measurements of an interaction channel whose absolute cross section can be calculated in a believable way and measurements of the beam characteristics. The following methods for making the mea-

surement luminosity are considered: measurement of the Coulomb region in pp collisions; Coulomb dissociation of Δ(1236); electron pair production in pp collisions; the van der Meer method; diffuse beam method; attenuation method for relative luminosity measurements; and luminosity measurement for collinear regions. (R.W.R.)

53772 (BNL–17021) SCHEME FOR ABSOLUTE CALIBRATION OF ISABELLE LUMINOSITY. Gobbi, B.; Rosen, J. L. (Brookhaven National Lab., Upton, N. Y.). [nd]. 9p. Dep. NTIS.

To effect the calibration one would like a simple reaction channel, easily identifiable, with reasonable rate and one which can be reliably predicted on the basis of precise measurement at lower energies. The interaction $p + p \rightarrow p + \Delta^+(1236)$ is proposed for this task. An accuracy of 1% seems achievable. Monte Carlo calculations of the energy and angular distributions of the nucleon and pion produced by the decay of the Coulomb-excited Δ^+ are shown. A feasible detection scheme is described. (3 figures) (R.W.R.)

53773 (BNL–17051) MOMENTUM MATCHING IN ISA LONG INSERTIONS. Garren, A.; Helm, R.; Month, M. (Brookhaven National Lab., Upton, N. Y.). 14 Jul 1972. 5p. Dep. NTIS.

In the long insertion options of the ISABELLE lattice, the momentum dispersion functions are designed to be zero. Quadrupoles and bending magnets at the ends of the insertions are used for this purpose. However, this momentum matching is destroyed within the insertion if focusing and bending of the beam for experimental purposes become coupled. The momentum mismatch due to this coupling is described, and some undesirable consequences are pointed out. The present ISABELLE options manifest this mismatch, and a modification that would solve the problem is proposed. Finally, some numerical results are given using the computer program SYNCH. (2 figures) (auth)

53774 (BNL–17056) MAGNET TOLERANCES IN ISABELLE AND NONLINEAR RESONANCES. Parzen, G. (Brookhaven National Lab., Upton, N. Y.). 26 Jul 1972. 3p. Dep. NTIS.

There is reason to believe that the nonlinear imperfection resonances, which are driven by random errors in the magnetic field, are likely to be considerably stronger in ISABELLE than they are in the ISR. This would require that ISABELLE have a set of magnetic correction elements to control the harmonics which excite the relevant nonlinear imperfection resonances. (1 figure) (auth)

53775 (BNL–17057) APPLICATION OF ISABELLE IN WHIPLASH MODE TO PRODUCE POLARIZED PROTON OR MONOENERGETIC NEUTRON BEAMS. Goldberg, M.; Moneti, G. C. (Brookhaven National Lab., Upton, N. Y.). 17 Jul 1972. 8p. Dep. NTIS.

The production of beams of polarized protons and monoenergetic neutrons by accelerating protons in ISABELLE in the Whiplash mode is discussed, and it is concluded that neither is possible with the design beam intensity because of the very small luminosity that is a characteristic of the Whiplash mode. The high magnification of the longitudinal component of the center-of-mass momentum of the final particles, another characteristic feature of the Whiplash mode, is also discussed; no useful applications are envisioned, however, because of the low luminosity levels. (4 figures, 3 tables) (R.W.R.)

53776 (BNL–17063) COULOMB INDUCED DEUTERON BREAK-UP OF ISABELLE. Gobbi, B.; Rosen, J. (Brookhaven National Lab., Upton, N. Y.). 2 Aug 1972. 1p. Dep. NTIS.

In connection with the possibility of a deuteron beam option for ISABELLE, it is important to know the cross section for deuteron breakup induced by the Coulomb field interaction. By use of the Weizsaecker–Williams formula this was calculated to be 0.3 mb; although fairly large, this value does not preclude any of the proposals presently being advanced. (R.W.R.)

53777 (BNL–17067) LUMINOSITY CONSIDERATIONS FOR COLLIDING ELECTRON AND PROTON BEAMS. Courant, E. D. (Brookhaven National Lab., Upton, N. Y.). 25 Jul 1972. 9p. Dep. NTIS.

The maximum obtainable luminosities for electron–proton colliding beam systems are estimated, subject to the constraints that the power radiated by electron synchrotron radiation is fixed (this limits a combination of electron energy and current) and the detuning (beam–beam interaction) of electrons by protons and vice versa must be kept below a certain limit. It is seen that high luminosity can be obtained either with a weakly bunched or unbunched proton beam and many electron bunches or with a single proton bunch and a single electron bunch, both very short. In the many-bunch mode the optimum luminosity is obtained at lower electron energy than in the single-bunch mode. (auth)

53778 (BNL–17068) DOES ISABELLE NEED UNEQUAL ENERGY RINGS? Lee, Y. Y. (Brookhaven National Lab., Upton, N. Y.). 22 Jun 1972. 2p. Dep. NTIS.

A few examples of reasons why there should be separately functioning storage accelerators are listed. (auth)

53779 (BNL–17142) LARGE APERTURE SPECTROMETER MAGNET FOR THE ISA AND THE POSSIBLE USE OF VISUAL DETECTORS. French, H.; Roe, B. P.; Gelfand, N.; Strand, R. C.; Weilhammer, P. (Brookhaven National Lab., Upton, N. Y.). 1972. 5p. Dep. NTIS.

It is proposed that a large aperture spectrometer magnet be designed as an integral part of the ISA machine to be pulsed with the machine. The design luminosity thus can be optimized in a configuration including the large magnet. Preliminary options concerning magnet types are given and it is argued that as a first survey it is likely to be used with visual detectors. At the ISA, as at lower energies, the strong forces will dominate the p + p interaction. The typical p + p event will be characterized by high track multiplicity and the small transverse momenta of the particles. It is felt that the understanding of these events will be essential if one is to achieve an explanation of the strong interaction. It is therefore considered important that the ISA be provided with a device which enables one to observe and analyze these events. (auth)

53780 (BNL–17152) EFFECT OF LOW-SYMMETRY MATCHED INSERTIONS. Month, M. (Brookhaven National Lab., Upton, N. Y.). 29 Dec 1971. 11p. Dep. NTIS.

The effects of low-periodicity insertions are considered. The insertions are assumed to have the basic properties suitable for particle experiments in storage rings. They are also assumed to be matched to the main lattice cells with respect to both betatron and momentum dispersion variables at a specific tune and momentum. For a momentum error, however, the tune is shifted and the matching is broken. This mismatching introduces instabilities at tunes directly related to the periodicity of the insertions, N. Gradient instabilities occur at all values of the tune given by $\nu \sim (N/2) \times$ integer, while dipole resonances occur at $\nu \sim N \times$ integer. Expressions characterizing these instabilities are derived. Specifically, for gradient instabilities, the growth in the β function and the available momentum aperture near the resonances are estimated. The use of sextupoles as correction devices, for reducing the β growth and opening the momentum aperture, is discussed. An idealized lattice with two-fold symmetry is treated as an example. (1 figure) (auth)

53781 (BNL–17153) VACUUM CHAMBER EDDY CURRENTS. Bittner, J. W. (Brookhaven National Lab., Upton, N. Y.). 24 Feb 1972. 6p. Dep. NTIS.

In order to reduce the power losses due to the beam-induced rf currents in the vacuum chamber of ISABELLE, it seems necessary to furnish the chamber with some kind of copper wall. Since the resistivity of this copper at 4.5°K will be about 100 times lower than that normally encountered at room temperature, it is worthwhile to estimate the effects of eddy currents induced by the slowly rising magnetic fields during the acceleration phase of the magnet cycle. It is found that, in the dipole case, the power dissipated by eddy currents approaches the losses due to beam-induced currents. This dissipation lasts, however, only during the 120 seconds rise time, and exists only in that fraction of the vacuum chamber passing through dipole magnets. It might, however, be a very valid reason to reduce the thickness of the copper wall. (1 figure) (R.W.R.)

53782 (CERN–72-14) INTERSECTING STORAGE RINGS. Lectures Given in the Academic Training Programme of CERN, 1971–1972. Keil, E. (European Organization for Nuclear Research, Geneva (Switzerland)). 21 Jul 1972. 53p. Dep. NTIS (U. S. Sales Only).

Topics include: why colliding beams?, why storage rings?, how to fill storage rings?, how is stacking in synchrotron phase space done?, does one need a good vacuum?, magnet system, rf system, beam transfer, and vacuum. The expected ISR performance is discussed; and space charge Q-shift including calculation of the linear space charge Q-shift, measurement of incoherent Q-shifts, and measurement of coherent Q-shifts is considered. Also, coherent instabilities, experimental data on beam lifetime, experimental data on beam size, and possible theoretical explanations of beam lifetime and beam growth are discussed. (W.H.K.)

Experimental Facilities

Refer also to abstract 54467.

53783 (DNPL/P-131) HIGH INTENSITY MUON BEAM DESIGN FOR CERN II. Aitken, T. W.; Clifft, R. W.; Gabathuler, E. (Daresbury Nuclear Physics Lab. (England)). Jul 1972. 15p. Dep. NTIS (U. S. Sales Only).

Results are presented of detailed investigations into the design of a muon beam-line incorporating a strong focusing decay channel. The principal objectives of the beam-line design are (i) to accept as many as possible of the pions produced at a primary target within a particular momentum band, (ii) to contain the pions and their subsequent decay muons within a decay channel, (iii) to remove all remaining pions at the end of the channel, (iv) to focus as many of the muons as possible on to an experimental target, and (v) to minimize the beam halo. A 1 km beam-line was developed capable of handling particles of momentum $\lesssim$300 GeV/c. Some performance figures are given. (auth)

53784 (LA-4874) PROCEEDINGS OF THE FIFTH LAMPF USERS MEETING HELD AT THE LOS ALAMOS SCIENTIFIC LABORATORY, LOS ALAMOS, N.M., NOVEMBER 8-9, 1971. Agnew, Lewis E.; Howard, Hillard H.; Miller, Billie F. (comps.) (Los Alamos Scientific Lab., N. Mex.). Mar 1972. Contract W-7405-eng-36. 168p. (CONF-711138). Dep. NTIS.

Separate abstracts were prepared for the 19 papers presented. (W.H.K.)

For abstracts of individual papers see: 53398, 53450, 53739, 53740, 53785–53796, 54195, 54876, and 54877.

53785 (LA-4874, pp 45-7) STATUS REPORT ON LAMPF RESEARCH PROPOSALS. Rosen, Louis (Los Alamos Scientific Lab., N. Mex.). Mar 1972.

From fifth LAMPF users meeting; Los Alamos, NM. (8 Nov 1971).

The members of the LAMPF Program Advisory Committee, Biomedical Applications Subcommittee, and Nuclear Chemistry Subcommittee are listed. The research proposals are tabulated according to the LAMPF channel, and action taken on the proposals including beam time assignments are tabulated according to the channel. (W.H.K.)

53786 (LA-4874, pp 48-50) LOW ENERGY PION CHANNEL. Burman, Robert L. (Los Alamos Scientific Lab., N. Mex.). Mar 1972.

From fifth LAMPF users meeting; Los Alamos, NM. (8 Nov 1971).

The proposed Low-Energy Pion Channel, designed to provide π^+ beams for the energy region from low energies (approximately 20 MeV) through the resonance region (approximately 300 MeV), is briefly described; and experiments proposed for the low energy pion channel are outlined. (W.H.K.)

53787 (LA-4874, pp 51-4) ENERGETIC PION CHANNEL AND SPECTROMETER (EPICS). Thiessen, H. A. (Los Alamos Scientific Lab., N. Mex.). Mar 1972.

From fifth LAMPF users meeting; Los Alamos, NM. (8 Nov 1971).

The optical design and experimental layout for the LAMPF Energetic Pion Channel and Spectrometer (EPICS) are briefly described, and the status of the project is outlined. Nine experiments approved for beam time at the EPICS facility are listed. (W.H.K.)

53788 (LA-4874, pp 55-8) PION AND PARTICLE PHYSICS (P^3). Macek, Robert J. (Los Alamos Scientific Lab., N. Mex.). Mar 1972.

From fifth LAMPF users meeting; Los Alamos, NM. (8 Nov 1971).

The status of the LAMPF Pion and Particle Physics (P^3) channel is outlined. Topics include status of the hardware, a brief summary of channel parameters including revised fluxes, the work of P^3 users last summer, and a summary of P^3 research proposals. (W.H.K.)

53789 (LA-4874, pp 59-62) STOPPED MUON CHANNEL. Thompson, Patrick A. (Los Alamos Scientific Lab., N. Mex.). Mar 1972.

From fifth LAMPF users meeting; Los Alamos, NM. (8 Nov 1971).

The status of the LAMPF stopped muon channel is summarized, and the estimated stopping rates for the muon channel and the estimated properties of the muon test beam are tabulated. (W.H.K.)

53790 (LA-4874, pp 63-6) NUCLEON PHYSICS LABORATORY (NPL). Hwang, Chester F. (Los Alamos Scientific Lab., N. Mex.). Mar 1972.

From fifth LAMPF users meeting; Los Alamos, NM. (8 Nov 1971).

The status of the LAMPF Nucleon Physics Laboratory is described including development of the polarized proton ion source, the polarized proton and deuterium target, low-energy operation, and micropulse operation. Proposals for experiments are briefly discussed. (W.H.K.)

53791 (LA-4874, pp 67-71) HIGH RESOLUTION PROTON SPECTROMETER (HRS). Spencer, James E. (Los Alamos Scientific Lab., N. Mex.). Mar 1972.

From fifth LAMPF users meeting; Los Alamos, NM. (8 Nov 1971).

The design and development status of the LAMPF High Resolution Proton Spectrometer is outlined. The beam optics and detector electronics are briefly discussed. (W.H.K.)

53792 (LA-4874, pp 72-7) NUCLEAR CHEMISTRY FACILITIES. Dropesky, Bruce J. (Los Alamos Scientific Lab., N. Mex.). Mar 1972.

From fifth LAMPF users meeting; Los Alamos, NM. (8 Nov 1971).

The LAMPF Nuclear Chemistry Laboratory, the hot cells of the Merrimac Service Area, the pneumatic rabbit system, and the proposed nuclear chemistry targeting stations are briefly described. A list of the initial set of nuclear chemistry experiments is given. (W.H.K.)

53793 (LA-4874, pp 78) BIOMEDICAL APPLICATIONS: BEAM LINE AND FACILITY. Hutson, Richard L. (Los Alamos Scientific Lab., N. Mex.). Mar 1972.

From fifth LAMPF users meeting; Los Alamos, NM. (8 Nov 1971).

The personnel structure involved in the LAMPF Pion Radiobiology and Radiotherapy Program is outlined, and the status of the Biomedical Pion Channel is briefly described. (W.H.K.)

53794 (LA-4874, pp 84-5) NEUTRINO FACILITY. Burman, Robert L. (Los Alamos Scientific Lab., N. Mex.). Mar 1972.

From fifth LAMPF users meeting; Los Alamos, NM. (8 Nov 1971).

A neutrino facility which fits directly behind the main proton line beam dump without modification of the dump is described. Essentially all of the neutrinos result from the $\pi^+ \rightarrow \mu^+ + \nu_\mu$ decays and $\mu^+ \rightarrow e^+ + \nu_e + \bar{\nu}_\mu$ decays. The spectra of these neutrinos is shown graphically. The mean energy in 35 MeV and the maximum energy is 53 MeV. The flux is expected to be about 3×10^7 ν/sec cm^2 of each type of neutrino. Initial proposals for experiments are listed. (W.H.K.)

53795 (LA-4874, pp 86-9) COMPUTING FACILITIES. Butler, Haro'1 S. (Los Alamos Scientific Lab., N. Mex.). Mar 1972.

From fifth LAMPF users meeting; Los Alamos, NM. (8 Nov 1971).

The status of the experimental data acquisition system at LAMPF is reviewed. Data reduction will be handled through the Central Computing Facility (CCF) which now has an inventory of two CDC-7600's and three CDC-6600's. CAMAC will be used as the standard for interfacing the experimental apparatus to each computer. The main beam lines of the accelerator may be controlled from CCF. (W.H.K.)

53796 (LA-4874, pp 92-8) PROMOTION OF THE ACADEMIC USES OF LAMPF. McDaniel, Paul W. (Division of Research (AEC), Washington, D. C.). Mar 1972.

From fifth LAMPF users meeting; Los Alamos, NM. (8 Nov 1971).

Attitudes and approaches that need to be established among the scientists at LAMPF in order to establish an understanding by the American public of the fundamental research program at LAMPF are suggested. (W.H.K.)

53797 (LA-DC-72-881) PION BEAMS AT LAMPF. Burman, R. L. (Los Alamos Scientific Lab., N. Mex.). [nd]. 17p. (CONF-710948-2). Dep. NTIS.

From International seminar on pion-nucleus interactions; Strasbourg, France (Sep 1971).

The three secondary pion channels at the Clinton P. Anderson Meson Physics Facility are described. The low-energy pion channel is designed to provide π^+ beams for the energy region from low energies (approximately 20 MeV) through the resonance region (approximately 300 MeV). Design features of the channel include good momentum resolution for nuclear structure experiments, a small (achromatic) spot for stopped pion experiments and total-absorption counter experiments, and high-intensity beams

at moderate resolution. EPICS is designed to have good energy resolution (<50 keV) and good angular resolution (<10 mrad), as well as a pion energy range and beam intensity sufficient to measure cross sections from low energies to above the (3,3) pion–nucleon resonance with adequate count rate. The complete system consists of a high-intensity, high resolution pion beam channel, a particle separator for reducing backgrounds, and two spectrometers. The channel produces a dispersed beam, in which the momentum of each particle is correlated with its position. The P^3 channel is a very flexible, general-purpose pion line capable of transmitting the highest-energy pions that the linac can produce. Additional characteristics are moderate resolution, high intensity, and the flexibility for matching to a wide range of experiment requirements. (11 figures) (R.W.R.)

53798 THEORY OF π/2-MODE BIPERIODIC DEFLECTORS. Bauer, W.; Hahn, H. (Univ., Karlsruhe, Ger.). Particle Accel.; 3: No. 4, 193–207(Aug 1972).

The extension of the rigorous theory of uniform-periodic iris-loaded deflectors to standing-wave π/2-mode biperiodic cavities is presented. The particular approach used restricts the solution to the π/2-mode, but it is possible to find the changes in outer diameter necessary to enforce confluence as required for maximum stability. Interaction impedance and shunt impedance are also computed, and good agreement with the few published results is found. (7 figures) (auth)

53799 PHYSICAL MEASUREMENTS INCLUDING DEPTH DOSE DATA AND ISODOSE CURVES FOR 8 MV ROENTGEN RAYS. Agarwal, S. K.; Scheele, R. V.; Wakley, J. (Univ. of Virginia, Charlottesville). Acta Radiol., Ther., Phys., Biol.; 11: No. 1, 97–105(Feb 1972).

The Arco Mevatron-7 linear accelerator at the University of Virginia, designed to operate at 1 MeV intervals between 3 and 10 MeV, is being used for roentgen rays produced by electron energies of 6 and 8 MeV. The electron energy, roentgen ray flatness, and absorbed dose are determined daily before the commencement of treatments. The energy is measured by extrapolating the electron range in aluminum. Central axis depth doses were measured in water for square fields from 16 to 625 cm^2, employing a remote control moving probe mechanism. The same mechanism was used to determine isodose curves. The results compared favorably with the existing data at this energy. (auth)

53800 MONOCHROMATIC METHOD FOR MEASURING THE 665 MeV MEAN PROTON ENERGY BY USING VAVILOV–CHERENKOV RADIATION. Zrelov, V. P.; Musin, M. A.; Pavlovic, P.; Sulek, P.; Janik, R. (Joint Inst. for Nuclear Research, Dubna, USSR). Nucl. Instrum. Methods; 103: No. 2, 261–9(1972).

The monochromatic method for measuring the proton energy by using the Vavilov–Cherenkov radiation and interference filters with $\lambda \approx 6000$ Å and a passband $\lambda = 100$ Å is described. The results of testing this method with a 665-MeV proton beam extracted from the synchrocyclotron of the Joint Institute for Nuclear Research in Dubna are presented. A measurement accuracy of ±0.02% was achieved which exceeds the accuracy of the best previously known methods by a factor of 5. (10 figures, 4 tables) (auth)

53801 SEPARATED HIGH-ENERGY ELECTRON BEAMS USING SYNCHROTRON RADIATION. Farley, F. J. M. (CERN, Geneva); Picasso, E.; Bracci, L. Nucl. Instrum. Methods; 103: No. 2, 325–9(1972).

Electrons with kinetic energy in the 100 GeV range may be separated from other particles by using their energy loss due to synchrotron radiation in a high-field magnet. The associated fluctuations in energy and angle are shown to be small enough for the method to be useful. Detailed design formulas are presented for several magnet configurations. (auth)

53802 ION BEAM MONITOR FOR NANOAMPERE CURRENTS. Hollis, M. J. (Chalk River Nuclear Labs., Ont.). Nucl. Instrum. Methods; 103: No. 2, 337–9(1972).

The ion beam current monitor can be used for continuous monitoring of MeV ion currents of 0.1 to 10 nA. It is particularly suited to ion channelling and similar experiments. (4 figures) (auth)

53803 TARGET CHAMBER FOR CHARGED PARTICLE INDUCED X-RAY FLUORESCENCE STUDIES. Feldl, E. J. (Kansas State Univ., Manhattan); Umbarger, C. J. Nucl. Instrum. Methods; 103: No. 2, 341–3(1972).

A target chamber is described which combines extremely low acquisition cost with precision adjustment and exchange of as many as 26 targets without breaking chamber vacuum. The chamber was designed for particle-induced x-ray fluorescence studies and allows great detection efficiency due to its small target–detector distance. To expand its usefulness, the chamber can also hold one solid state surface barrier detector at 90° with respect to the beam. This feature allows charge-particle studies as well as particle–gamma ray coincidence measurements. (3 figures) (auth)

53804 COMMENTS ON INTENSITY ESTIMATION FOR A NEUTRON BEAM FOR BIOLOGICAL AND MEDICAL APPLICATIONS. Watson, J. W. (Univ. of Manitoba, Winnipeg). Nucl. Instrum. Methods; 103: No. 2, 421(1972).

Recently published estimations of neutron spectra from the thick target Be(d,n) reaction for biological and medical use are compared with existing data. The estimated and experimental spectra are in reasonable qualitative agreement. (1 figure) (auth)

PHYSICS (ASTROPHYSICS AND COSMOLOGY)

Refer also to abstract 54870.

Cosmic Radiation

Refer also to abstracts 53276, 54185, 54313, 54878, 54888, 54889, and 54964.

53805 (N-71-30295) DETERMINATION OF HEAVY NUCLEI CHARGES. Semikoz, V. B. Translated from report Pr-13. 9p. (NASA-TT-F-13743). NTIS.

The number of delta electrons formed by $N = Z/(137\beta)$, where Z is the charge, and β is the velocity of the nucleus, is calculated. Good agreement was observed with the Born formula (at $\eta < 0.3$) and with the Rutherford formula (at $\eta > 1.5$), which give the same results in extreme cases ($\eta \ll 1$ and $\eta \gg 1$, respectively). If the parameter η is ~ 1, then it is necessary to use the exact Mott formula for differential cross sections whose numerical integration is carried out with allowances for kinematic scattering of the nucleus by target electrons. In this case, the introduced correction to charge, Z_{15}, determined in the first Born approximation, is very large, especially for the heavy nuclei of the SH group. (auth) (STAR)

53806 (NASA-TM-X-2440, pp 209-14) CHEMICAL COMPOSITION AND ENERGY CONTENT OF THE ENERGETIC COSMIC RADIATION. Waddington, C. J. (Univ of Minnesota, Minneapolis). Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

A brief survey is made of the present knowledge of the composition and energy spectra of the primary cosmic radiation. The total energy carried by all forms of cosmic radiation that have appreciable penetrability into matter is evaluated. This information, when combined with a knowledge of the rate at which the different components deposit energy in traversing matter, would permit calculations of the dose from exposure to the primary cosmic radiation. It is concluded that the overall radiation effects are rather small but local damage can be of much greater significance. (auth)

53807 (NASA-TM-X-2440, pp 908-13) EXPERIMENTAL DETERMINATION OF COSMIC-RAY CHARGED-PARTICLE INTENSITY PROFILES IN THE ATMOSPHERE. Lowder, W. M.; Raft, P. D.; Beck, H. L. (Atomic Energy Commission, New York). Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

Absolute cosmic-ray free-air ionization and charged-particle fluxes and dose rates throughout the atmosphere were measured on a series of balloon flights that commenced in 1968. Argon-filled ionization chambers equipped with solid-state electrometers, with different gas pressures and steel-wall thicknesses, and a pair of aluminum-wall GM counters have provided the basic data, which are supplemented by measurements with air-filled and tissue-equivalent ionization chambers and a scintillation spectrometer. Detailed laboratory experiments, together with analyses of the theoretical aspects of the detector responses to cosmic radiation, indicate that these profiles can be determined to an overall accuracy of ±5%. Data from various balloon flights at 53°N and 42°N geomagnetic latitude provide ionization profiles consistent with earlier results in the lower atmosphere, but 20% lower than comparable data obtained by the California Institute of Technology. No explanation has yet been found for this discrepancy, although a quantitatively similar one was previously noted by the University of Minnesota group. The results indicate a total charged-particle free-air ionization (dose rate) at 53°N latitude of 6.3 I (9.5 μrad/hr), 114 I (170 μrad/hr), and 290 I (436 μrad/hr) at 10,000, 35,000, and 65,000 ft, respectively. These data are approximately minimum values for the 11-year solar-activity cycle. The ionization and flux data are compared with the analytical calculations of O'Brien, with generally satisfactory agreement. (auth)

53808 (ORNL-tr-2620) BUILDUP OF COSMIC ISOTOPES IN IRON METEORITES. Barashenkov, V. S.; Sobolevskii, N. M.; Toneev, V. D. (Joint Inst. for Nuclear Research, Dubna (USSR)). Translated for Oak Ridge National Lab., Tenn., from report JINR-P2-6225. 9p. Dep. NTIS.

The formation rates of cosmogenic isotopes ^{22}Na, ^{36}Cl, ^{40}K, and ^{49}V in iron meteorites were calculated using the Monte-Carlo method. The question about variations of the cosmic-ray intensities is discussed. Preatmospheric radius of the Arus-Yardymlinsky meteorite is estimated. The results were compared with those obtained by other authors. (auth)

53809 EQUILIBRIUM ENERGY SPECTRUM FOR THE GALACTIC COSMIC ELECTRONS. Suh, Paul K. (Grumman Aerospace Corp., Bethpage, N. Y.). Astron. Astrophys.; 20: No. 3, 375-82 (Sep 1972).

A perturbational analysis of the cosmic electron diffusion equation is developed. In the high-energy domain, cosmic electron diffusion parallel to the galactic disk slab appears not to affect significantly the determination of the equilibrium electron energy spectrum. Diffusion across the galactic disk slab in the high-energy domain is examined in detail. An active cosmic electron leakage at the disk-halo boundaries, coupled with diffusion across the disk slab, sensitiviely affects the cosmic electron spectral behavior up to a considerably high-energy domain. In the high-energy domain, the closed-disk model appears to prevail. In the low-energy domain, the leakage-time may become comparatively long, thus leading to the possible validity of a quasi-open-disk model. (auth)

53810 ISOTOPIC COMPOSITIONS OF RARE GASES IN THE CARBONACEOUS CHONDRITES MOKOIA AND ALLENDE. Manuel, O. K.; Wright, R. J.; Miller, D. K.; Kuroda, P. K. (Univ. of Arkansas, Fayetteville). Geochim. Cosomchim. Acta; 36: No. 9, 961-83(Sep 1972).

The isotopic compositions were measured mass spectrometrically for neon, argon, krypton, and xenon released from the carbonaceous chondrites Mokoia and Allende in stepwise heating experiments. The isotopic compositions of rare gases released from the meteorites at different temperatures varied quite considerably. The observed minimum and maximum values were, for example, as follows: $^{20}Ne/^{22}Ne = 2.10$ (Allende 800°C) and 12.95 (Mokoia 400°C); $^{36}Ar/^{38}Ar = 4.20$ (Allende 1600°C) and 6.05 (Allende 800°C); $^{86}Kr/^{80}Kr = 3.140$ (Allende 1000°C) and 3.306 (Mokoia 600°C); $^{134}Xe/^{130}Xe = 1.019$ (Allende 800°C) and 1.192 (Allende 1400°C). A marked enrichment of ^{129}Xe due to the decay of extinct nuclide ^{129}I was observed in both meteorites. The variations of the isotopic ratios are partly caused by the presence of cosmic-ray spallation and neutron-capture products. In addition, however, a marked trend of mass-dependent variation of the isotopic ratios was observed. The rare gas isotopes released from the meteorites appear to be systematically mass-fractionated relative to the relative abundances of the average carbonaceous chondrite (AVCC). It seems that this phenomenon can be best explained by assuming that there exist reservoirs of two isotopically distinct gases in the meteorites and mixtures of these gases are being released at each temperature fraction. The two different gases being considered here are most likely the so-called solar and planetary rare gases, whose isotopic compositions are quite different. (auth)

53811 CHARACTERISTICS OF COSMIC RAY DIURNAL VARIATION FROM DEEP RIVER NEUTRON AND MESON DATA AND TEMPERATURE EFFECTS. Agrawal, S. P.; Ananth, A. G.; Rao, U. R. (Physical Research Lab., Ahmedabad, India). Can. J. Phys.; 50: No. 12, 1323-31(15 Jun 1972).

From an extensive analysis of Deep River meson data for over 5 years, new temperature coefficients were derived for correcting the meson data. It is shown that meson data corrected using new coefficients yield values of diurnal and semidiurnal anisotropy consistent with those obtained from neutron monitors. Using the temperature-corrected meson and neutron data, the upper cutoff rigidity beyond which the diurnal variation ceases is shown to vary with solar cycle showing a minimum of about 35 GV during the Quiet Solar Year of 1965, and a maximum of ≈125 GV during 1968-1969. (auth)

53812 THREE-DIMENSIONAL COSMIC-RAY ANISOTROPY IN INTERPLANETARY SPACE. III. ORIGIN OF COSMIC RAY SOLAR SEMI-DIURNAL VARIATION. Nagashima, Kazuo; Ueno, Hirosachi; Fujimoto, Kazuhiko; Fujii, Zenjiro; Kondo, Ichiro (Nagoya Univ., Japan). Rep. Ionosphere Space Res. Jap.; 26: No. 1-2, 1-30(1972).

Annual modulation of cosmic-ray daily variation, observed by ion-chambers at Cheltenham and Christchurch, was studied in order to determine the anisotropy responsible for the solar semi-diurnal variation of cosmic rays. Two hypotheses have been proposed for the explanation of the anisotropy. One is called the density-gradient hypothesis that assumes the existence of cosmic-ray density gradient in the direction perpendicular to the ecliptic plane as a result of diffusion processes. The other is called the

pitch-angle distribution hypothesis that assumes a specific form of cosmic-ray pitch-angle distribution against the interplanetary magnetic line of force as a result of a particle's spiral motion along the direction. Although cosmic-ray space distributions, predicted from these hypotheses, are different from one another, they each produce semidiurnal variation similar to the other's. Therefore, they cannot be discriminated from each other by observing simply the semidiurnal variation. In order to determine the origin of the semidiurnal variation, it is required to observe a special diurnal variation, characterizing these anisotropies. Different from the usual diurnal variation, the special variation shows a strange behavior that, in spite of its finite daily amplitude, its yearly average becomes very small or zero as a result of its annual modulation due to the Earth's revolution around the Sun. Because of this nature, it is necessary to observe the annual modulations of the special diurnal variation for the determination of the origin. The present analysis of the annual modulation will give some decisive evidence that will lend support to the pitch-angle distribution hypothesis. (auth)

53813 THREE-DIMENSIONAL COSMIC RAY ANISOTROPY IN INTERPLANETARY SPACE. IV. ORIGIN OF SOLAR SEMIDIURNAL VARIATION. Nagashima, Kazuo; Fujimoto, Kazuhiko; Fujii, Zenjiro; Ueno, Hirosachi; Kondo, Ichiro (Nagoya Univ., Japan). Rep. Ionosphere Space Res. Jap.; 26: No. 1-2, 31-68 (1972).

Origin of solar semidiurnal variation of cosmic-ray intensity is studied on the basis of the analytical method developed in Parts I and II, that utilizes the annual modulation of daily variation due to the Earth's revolution around the Sun. Data used for the analysis are those of multi-directional large area cosmic-ray telescope at Mt. Norikura, which can be made insensitive to the atmospheric effects by taking differences among intensities of different directions. Similar to the conclusion in Part III, the result of the present analysis gives positive support to the pitch-angle distribution hypothesis and eliminates the possibility of density gradient hypothesis for the explanation of solar semidiurnal variation. The space distribution obtained is of $\sin^2 \chi$-type, its reference axis of anisotropy being in the direction of interplanetary magnetic line of force, where χ is the angle between the reference axis and the cosmic-ray incident direction. The rigidity spectrum is of power-exponential type with its maximum at about $P_M = 60-100$ GV. (auth)

53814 12th INTERNATIONAL CONFERENCE ON COSMIC RAYS, HOBART, AUSTRALIA, AUGUST 16-25, 1971. VOLUME 1. Hobart, Australia; International Union of Pure and Applied Physics (1971). 436p. (CONF-710807-(Vol.1)).

One hundred and twenty papers dealing with origin and galactic phenomena including energetic primary protons and other nuclei, electrons, x rays, and gamma rays, as well as relevant information from radio astronomy and other branches of astrophysics are included. Of these, 53 papers are in abstract form only. The remaining 67 are given separate abstracts. (Australia)

For abstracts of individual papers see: 53815-53869, 53917-53926, 53992, and 54000.

53815 INTERACTION OF COSMIC RAYS WITH INTERSTELLAR MATTER AND POSSIBLE EXCITATION OF X-RAY LINES. Verma, Satya Dev (Louisiana State Univ., Baton Rouge). pp 31-6 of 12th International Conference on Cosmic Rays, Hobart, Australia. Vol. 1. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.1).

There are unexplained excess intensities in the 0.25- to 1-keV energy interval of the diffuse cosmic x-ray spectrum. It is suggested that these may be due to characteristic x-ray line spectra from interstellar matter. These spectra may be excited by the interaction of energetic charged cosmic-ray particles with interstellar matter. Since the cross sections for such interactions are known only up to 40 MeV, the intensities of the x-ray lines can be estimated to within an order of magnitude only. It is suggested that the observation of cosmic x-ray lines may serve as a powerful tool for studying interstellar matter. Information about interstellar matter is difficult to obtain by other methods. (auth) (Australia)

53816 OBSERVATION OF COSMIC GAMMA RADIATION ABOVE 10 MeV. Kinzer, R. L.; Seeman, N.; Share, G. H. (Naval Research Lab., Washington, D. C.). pp 51-5 of 12th International Conference on Cosmic Rays, Hobart, Australia. Vol. 1. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.1).

A search for gamma radiation above 20 MeV from the vicinity of the Crab Nebula was performed with an emulsion spark-chamber telescope capable of an angular resolution of $\leq 2\frac{1}{2}°$. Upper limits at the 95% confidence level are deduced for the total emission from the Crab and for the emission from the galactic plane in the direction of the anticenter. These limits are 2×10^{-4} γ/cm^2-sec for the Crab and 4×10^{-4} γ/cm^2-sec-rad for the plane. A linear extrapolation of the recorded gamma-ray flux vs. atmospheric depth allows one to set an upper limit of 4×10^{-3} γ/cm^2-sec-sr on the flux of extraterrestrial diffuse radiation above 10 MeV. Information was also obtained on the spectrum of secondary gamma rays near the top of the atmosphere. Preliminary results are consistent with a photon spectrum calculated by Beuermann (1971) which is dominated by bremsstrahlung below ~70 MeV and by π^0-decay above. (auth) (Australia)

53817 0.511 MeV GAMMA RAYS MEASURED WITH THE Ge(Li) DETECTOR AT THE BALLOON ALTITUDE. Nakagawa, S.; Tsukuda, M.; Okudaira, K.; (and others) (Rikkyo Univ., Tokyo). pp 77-83 of 12th International Conference on Cosmic Rays, Hobart, Australia. Vol. 1. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.1).

The 0.511-MeV gamma rays produced by the annihilation process of the positron and the negatron in the atmosphere were observed with the balloon-borne phoswich scintillation counters and high resolution Ge(Li) detector from 1967 to 1970. Balloon observations were carried out three times at the geomagnetic latitude $\lambda = 26°$N or 27.5°N, and results of the 0.511-MeV gamma-ray observations were consistent. The intensity of the 0.511-MeV gamma rays was 18.5 ± 4.7 photons $\cdot$ cm^{-2} $\cdot$ sec^{-1} at the atmospheric depth 7 g cm^{-2} and the production rate in a 1 cm^2 column of the atmosphere was 36.2 photons cm^{-1} sec^{-1}, which was in good agreement with the estimated value based on the cascade shower theory and energy balance of cosmic rays. The intensity and the production rate of the 0.511-MeV gamma rays in the atmosphere were compared with ones observed by other investigators. (auth) (Australia)

53818 COSMIC FLUX OF LOW ENERGY GAMMA RAYS. Damle, S. V.; Daniel, R. R.; Joseph, George; Lavakare, P. J. (Tata Inst. of Fundamental Research, Bombay). pp 84-9 of 12th International Conference on Cosmic Rays, Hobart, Australia. Vol. 1. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.1).

Measurements were made on the cosmic gamma rays of energy between 0.25 and 4.2 MeV from a balloon experiment made near the geomagnetic equator using a collimated 3" × 3" NaI(Tl) crystal assembly. The depth-intensity curves were used to obtain the contribution due to the cosmic gamma rays in this energy interval. An unfolding of the counting rates was performed to obtain the energy spectrum of the diffuse cosmic gamma rays. It appears that a spectrum of the type $E^{-1.5}$ fitted to the data beyond 200 keV will be consistent with other data available to this energy range. Upper limits on low energy gamma-ray fluxes from Sco X-1 and the Galactic centre region are also reported. (auth) (Australia)

53819 FLUX OF GALACTIC HIGH-ENERGY GAMMA RAYS. Clark, G. W. (Massachusetts Inst. of Tech., Cambridge); Garmire, G. P.; Kraushaar, W. L. pp 91-6 of 12th International Conference on Cosmic Rays, Hobart, Australia. Vol. 1. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.1).

A recalibration of the OSO-3 high-energy gamma-ray detector provided the following galactic gamma-ray fluxes; F_γ(anticenter) = $(3^{+1.1}_{-1.2}) \times 10^{-5}$ photons/cm^2 sec radian and F_γ(center) = $(1.2^{+.6}_{-.5}) \times 10^{-4}$ photons/cm^2 sec radian for energies above 100 MeV. Possible sources of error are discussed. Several galactic models to explain the observations are presented. (auth) (Australia)

53820 COSMIC GAMMA RAYS FROM SUPRATHERMAL PROTON BREMSSTRAHLUNG. Jones, Frank C. (Goddard Space Flight Center, Greenbelt, Md.). pp 97-101 of 12th International Conference on Cosmic Rays, Hobart, Australia. Vol. 1. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.1).

The radiation cross section for relativistic suprathermal proton bremsstrahlung was calculated using the Weizsaecker-Williams method. Curves representing the radiation spectra for protons of various energies are shown and an approximate

expression for the spectrum, valid for photon energies greater than a few MeV, is given. This approximate spectrum is of the form such that the general analysis may be applied. This analysis shows that an inverse power-law spectrum of protons will produce, via the suprathermal proton bremsstrahlung process, an inverse power-law spectrum of gamma rays that is one power steeper than that of the protons. This makes it quite unlikely, contrary to a previously published report, that this process can contribute significantly to cosmic gamma rays. (auth) (Australia)

53821 PRIMARY ELECTRON OBSERVATIONS (3 ≤ E ≤ 15 GeV) RECORDED ON THE ESRO II SATELLITE. Marsden, P. L.; Jakeways, R.; Calder, I. R. (Univ. of Leeds, Eng.). pp 110-15 of 12th International Conference on Cosmic Rays, Hobart, Australia. Vol. 1. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug. 1971). See CONF-710807-(Vol.1).

Previously reported preliminary observations from the Leeds Univ., electron experiment on the ESRO II satellite were re-examined and together with new data and calibrations were used to redetermine the primary electron spectrum for energies between 3 and 15 GeV. In addition, results on the modulation of the electron flux in the same energy range are presented. (auth) (Australia)

53822 FLUX AND ENERGY SPECTRUM OF COSMIC RAY ELECTRONS BETWEEN 10 AND 1000 GeV. Meyer, Peter; Mueller, Dietrich (Univ. of Chicago). pp 117-21 of 12th International Conference on Cosmic Rays, Hobart, Australia. Vol. 1. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.1).

A balloon borne counter-detector with a geometry factor of 0.1 m^2 ster was exposed for a total of 64 hours under about 4.6 g/cm^2 of residual atmosphere above Palestine, Texas, in 1970. The experimental technique and the method of data analysis are described, and preliminary results of this investigation, based on about 45% of the total amount of available data, are presented. The resulting electron flux is slightly lower than that previously reported and can, over the entire energy range, be represented by a power law with spectral index of about −2.8. (auth) (Australia)

53823 PRIMARY COSMIC RAY ELECTRON SPECTRUM FROM 10 GeV TO ABOUT 200 GeV. Silverberg, R. F.; Ormes, J. F.; Balasubrahmanyan, V. K.; Ryan, M. J. (Goddard Space Flight Center, Greenbelt, Md.). pp 122-7 of 12th International Conference on Cosmic Rays, Hobart, Australia. Vol. 1. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.1).

An ionization spectrometer consisting of 10.8 radiation lengths of tungsten and 35 radiation lengths of iron was used to determine the energy spectrum of cosmic-ray electrons above 10 GeV. The spectrometer was calibrated with electrons from 5.4 to 18 GeV at the Stanford Linear Accelerator and then flown at an altitude of 6 $gm-cm^{-2}$ for 16 hours. Separation of electron initiated events from proton events was achieved by utilizing starting point distributions, the shower development in tungsten, and the energy deposited in the large thickness of iron absorber. The exponent of the differential energy spectrum of the electrons was −3.1 ± 0.2 while the exponent of the background was consistent with the proton exponent of −2.7 ± .2. (auth) (Australia)

53824 METHOD FOR DETERMINING THE MEAN ATOMIC MASS OF THE ELEMENTS IN THE PRIMARY COSMIC RADIATION THROUGHOUT THE LATITUDE SENSITIVE PART OF THE SPECTRUM. Lund, N.; Lundgaard Rasmussen, Ib; Peters, B. (Danish Space Research Inst., Lyngby). pp 130-7 of 12th International Conference on Cosmic Rays, Hobart, Australia. Vol. 1. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.1).

It is possible to obtain accurate results on the relative charge to mass ratios for the elements in the primary cosmic radiation with the help of the Earth's magnetic field, in the form of a set of ratios between any two elements i and j

$$\frac{\left\langle \left(\frac{Z_i}{A_i}\right)^{\gamma_i} \right\rangle^{\gamma_j/\gamma_i}}{\left\langle \left(\frac{Z_j}{A_j}\right)^{\gamma_j} \right\rangle} = \frac{1}{C_{ij} K} \frac{R_i}{R_j}$$

The quantities which must be measured during an experiment are the local power exponents γ_i and γ_j and the flux ratio of the two elements both observed at equal rigidity cut-off (R_ρ) and at equal pulse height threshold (R_q). An accuracy of 5% for the γ's and about 0.5% for R_ρ and R_q is sufficient to obtain the relative masses to about 0.1 neutron mass for all elements up to silicon, and 0.2 neutron masses for iron. $C_{\rho q}$ is a calculated correction arising from the limited velocity resolution (and the nonuniformity) of the counters. K, which is very close to unity, is the residual uncertainty introduced by the unknown structure of the penumbra of the geomagnetic cut-offs. If the spectra of the two elements are found to be alike ($\gamma_i = \gamma_j$) then K = 1 and the structure of the penumbra does not enter the result at all. (auth) (Australia)

53825 UPPER LIMIT ON THE FLUX OF PRIMARY COSMIC RAY ANTI-ALPHA PARTICLES FROM 0.3 TO 3 GeV/NUCLEON. Evenson, Paul; Meyer, Peter (Univ. of Chicago). pp 138-43 of 12th International Conference on Cosmic Rays, Hobart, Australia. Vol. 1. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.1).

A preliminaty analysis of approximately 1200 alpha particle events gathered on three high-altitude balloon flights in summer 1970 at Ft. Churchill, Canada, was made using scintillation counters to measure time of flight and energy loss for each event and photographs of a series of spark chambers to record the deflection of each particle in the field of a permanent magnet. No anti-particles were identified. This implies an upper limit of 0.24% (at the 95% confidence level) on the flux of anti-alpha particles in the energy interval 0.3 to 3 GeV/nucleon. (auth) (Australia)

53826 MEASUREMENT OF THE PRIMARY COSMIC RAY NUCLEAR RIGIDITY SPECTRA FOR INDIVIDUAL ELEMENTS OF CHARGE Z ≥ 2. Buffington, A.; Smith, L. H.; Smoot, G.; Wahlig, M. A.; Alvarez, L. W. (Univ. of California, Berkeley). pp 147-54 of 12th International Conference on Cosmic Rays, Hobart, Australia. Vol. 1. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.1).

A superconducting magnetic spectrometer was flown to about 5 gm/cm^2 residual atmosphere on September 18, 1970, and May 7, 1971, by a balloon. 12,500 events with charge 3 and greater were rigidity analyzed on the two balloon flights. The trigger criteria were changed for a short while on each flight so that 12,000 helium nuclei could be momentum analyzed. (auth) (Australia)

53827 MEASUREMENT OF THE LOW ENERGY HELIUM ISOTOPES IN THE PRIMARY COSMIC RAYS. Tamai, E.; Narita, N.; Sakai, T. (Nihon Univ., Chiba, Japan). pp 156-61 of 12th International Conference on Cosmic Rays, Hobart, Australia. Vol. 1. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.1).

The isotopic composition of low-energy He nuclei in primary cosmic radiation was analyzed, using a nuclear emulsion stack. The abundance ratio of ^3He nuclei to total He nuclei at the top of the atmosphere was determined to be 11.8%, in the kinetic energy interval of 100 to 260 MeV/n. From this ratio, a mean path length traversed by low-energy cosmic rays from their source to the earth is estimated. (auth) (Australia)

53828 PRODUCTION OF ^2H AND ^3He NUCLEI IN COSMIC RAYS AND PROPAGATION OF PROTONS AND HELIUM NUCLEI THROUGH INTERSTELLAR SPACE. Biswas, S.; Ramadurai, S. (Tata Inst. of Fundamental Research, Bombay). pp 162-7 of 12th International Conference on Cosmic Rays, Hobart, Australia. Vol. 1. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.1).

Final results of detailed calculations on the intensity and energy spectra of ^2H and ^3He nuclei in cosmic rays are presented. Calculations take into account (a) energy dependent cross sections of thirteen nuclear reactions involving cosmic-ray protons and alpha particles with interstellar hydrogen and helium nuclei; (b) angular distribution and kinematics of these reactions; (c) ionization loss of primary and secondary nuclei; and (d) elastic collisions of protons and helium nuclei. It was assumed that the source spectra are a power law in rigidity, and Fermi spectrum. The following models for the distribution of path lengths were examined: (i) slab, (ii) gaussian, and (iii) exponential. The results of the cal-

culations and comparisons with available experimental data on $^2H/^4He$ and $^3He/(^3He + ^4He)$ ratios showed that a gaussian distribution of path lengths with mean amount of interstellar matter of 6.5 g cm^{-2} explained both these ratios and their energy dependence in the range 30 to 1000 MeV/n. An exponential distribution of path lengths with uniform distribution of sources is not in agreement with observations. (auth) (Australia)

53829 COSMIC RAY PROTON AND HELIUM SPECTRA ABOVE 50 GeV. Ryan, M. J.; Balasubrahmanyan, V. K.; Ormes, J. F. (Goddard Space Flight Center, Greenbelt, Md.). pp 173-7 of 12th International Conference on Cosmic Rays, Hobart, Australia. Vol. 1. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.1).

The primary cosmic-ray proton and He spectra from 50 to 2000 GeV were measured by an ionization spectrometer flown on a balloon at an altitude of 6 gm cm^{-2} for 16 hours. The geometrical factor of the instrument was 300 cm^2 sterad and more than 5,000 events were observed. At low energies, the energies of individual events can be determined to within ±30%. At higher energies, the cascade is not fully contained within the four mean free path thick spectrometer and the problems of estimating the energies of these events are discussed. The proton spectrum continues with constant exponent = -2.7 ± 0.1 up to energies greater than 1,000 GeV. This spectrum is in agreement with the results of Pinkau et al. (1969) at the low energies. However, there is no evidence for the spectral break at about 1,000 GeV. (auth) (Australia)

53830 CHARGE COMPOSITION OF GALACTIC COSMIC RADIATION. Ormes, J. F.; Balasubrahmanyan, V. K.; Ryan, M. J. (Goddard Space Flight Center, Greenbelt, Md.). pp 178-83 of 12th International Conference on Cosmic Rays, Hobart, Australia. Vol. 1. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.1).

Experimental results from the balloon borne ionization spectrometer flown in November 1970 enabled the extension of the measurement of the energy spectra of cosmic rays to 10^{12} eV. The exposure factor for this flight was 1825 m^2-sr-sec and approximately 10,000 nuclei with $Z \geq 3$ were observed. For nuclei with $Z \sim 6$, charges could be resolved to ±0.2 units. The technique used for the measurement of energies of complex nuclei using an ionization spectrometer is reported. Differential spectra of individual nuclei from lithium to oxygen and groups of nuclei with Z = 10 to 14, 15 to 19, 20 to 23, and 24 to 30 were measured. The differential spectra of these nuclear species for the energy range 2×10^{10} eV to 10^{12} eV could be described in a power-law representation with an exponent −2.6. The results indicate that the composition of galactic cosmic rays remains similar to that observed at lower energies. These results from direct measurements, provide evidence for the processes of source acceleration, and interstellar propagation remaining essentially energy independent up to 10^{12} eV. (auth) (Australia)

53831 NUCLEAR-ELECTROMAGNETIC CASCADES FROM ALPHA PARTICLES INCIDENT ON AN IRON ABSORBER. Jones, W. V. (Louisiana State Univ., Baton Rouge). pp 184-9 of 12th International Conference on Cosmic Rays, Hobart, Australia. Vol. 1. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.1).

Mean values and fluctuations of the nuclear-electromagnetic cascade development resulting from alpha particles incident on an iron absorber were determined for the primary energy range 10 to 300 GeV/N. This was accomplished by using a three-dimensional Monte Carlo simulation of the cascade process. The model used was first adjusted until it gave predictions for a small ionization spectrometer which agreed with measurements obtained by exposing the same spectrometer to 10, 20.5, and 28 GeV/c protons at an accelerator. The calculations were then modified to apply to high-energy alpha particles. The results show that measurements of the energies of alpha particles incident on an iron spectrometer with six interaction lengths total depth can be made with accuracies ranging from ~5% at 300 GeV/N to ~16% at 10 GeV/N. (auth) (Australia)

53832 NUCLEAR-ELECTROMAGNETIC CASCADE FROM NUCLEI WITH $Z \geq 3$. Jones, W. V. (Louisiana State Univ., Baton Rouge). pp 190-5 of 12th International Conference on Cosmic Rays, Hobart, Australia. Vol. 1. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.1).

A Monte Carlo simulation method was developed for studying nuclear-electromagnetic cascades initiated by high-energy nuclei with $Z \geq 3$ incident on heavy absorbers. The calculations are based on a cascade model which was first adjusted until it agreed with measurements made with protons at an accelerator. Modifications of the model used for protons include the incorporation of the probabilities for fragmentation of heavy nuclei into lighter nuclei, alpha particles, and nucleons. Mean values and fluctuations of the equivalent numbers of particles in the cascades at various depths in an iron absorber are presented for protons, carbon, and iron nuclei over the 30- to 300-GeV/N energy range. (auth) (Australia)

53833 NEW OBSERVATIONS AND CALCULATIONS OF PRIMARY Be/B IN THE COSMIC RAYS. O'Dell, F. W.; Shapiro, M. M.; Silberberg, R.; Tsao, C. H. (Naval Research Lab., Washington, D. C.). pp 197-202 of 12th International Conference on Cosmic Rays, Hobart, Australia. Vol. 1. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.1).

The fate of ^{10}Be in cosmic rays depends upon cosmic-ray lifetime, and determines the arriving ratio Be/B. In a Texas balloon flight, an emulsion detector stack was exposed. Data yielded a Be/B ratio of 0.37 ± 0.05 at the top of the atmosphere. This compared with a value 0.37 ± 0.07 from previous, comparable emulsion experiments, and with 0.40 ± 0.03 obtained with a counter telescope. Combining all three values (rigidity threshold ~4.5 GV) gave a Be/B ratio of 0.39 ± 0.03. New, calculated estimates of Be/B were, respectively, 0.42 ± 0.06 and 0.29 ± 0.05 for survival and decay of the ^{10}Be. The observations were more compatible with substantial survival of the ^{10}Be, and the confinement time of cosmic-ray nuclei is probably less than 50 million years—possibly much less. (auth) (Australia)

53834 RIGIDITY SPECTRUM OF $Z \geq 3$ NUCLEI FROM 5 GeV TO OVER 300 GeV. Golden, R. L. (Manned Spacecraft Center, Houston, Tex.); Adams, J. H.; Boykin, W. R.; (and others). pp 203-5 of 12th International Conference on Cosmic Rays, Hobart, Australia. Vol. 1. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.1).

A 46 cm^2-sr geometry factor superconducting magnet emulsion spectrometer with resolution exceeding 300 GV was flown for 8 hours at Palestine, Texas, on August 22, 1969. The data gathered on $Z \geq 3$ nuclei indicated a differential rigidity spectrum of the form $\rho^{-2.5 \pm 1}$ for rigidities of 8 to 300 GV. Spectral structure in the region 5 to 8 GV was not consistent with geomagnetic cutoff calculations. The data were also divided into L, M, and H charge groups. Spectra for the different groups were mutually consistent. No antinuclei were observed. Preliminary results from 13 hours of flight in Parana, Argentina, are presented. (auth) (Australia)

53835 ENERGY DEPENDENCE OF THE ABUNDANCES OF GALACTIC He, L, AND M NUCLEI FROM SATELLITE MEASUREMENTS. Garcia-Munoz, M.; Mason, G. M.; Simpson, J. A. (Univ. of Chicago). pp 209-14 of 12th International Conference on Cosmic Rays, Hobart, Australia. Vol. 1. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.1).

The differential energy spectra of He and the L and M nuclei were measured from 10 to 1000 MeV per nucleon with cosmic-ray telescopes on board the IMP-4 and IMP-5 satellites in 1967–1970. The ratios He/M and L/M derived from these spectra were found to be nearly energy independent within errors of ~15%, and equal to ~15 and ~0.25, respectively. It was found that a steady state model with an exponential distribution of path lengths and a 6 ± 1 g/cm^2 leakage mean free path can produce the observed high-energy L nuclei. However, as found in earlier observations, the observed ratios for He/M and L/M depart from the calculated ratios below ~100 MeV/N. This discrepancy with the equilibrium model is discussed in terms of additional mechanisms operative at low energies, including adiabatic deceleration in the solar system. The parameters derived from the above observations were used to discuss (1) the calculated versus the observed energy dependence of the ratios C/O and N/O, and (2) the question of whether N nuclei are required in the source composition in order to reproduce the observed N/O = 0.32 ± 0.05 at high energy. (auth) (Australia)

53836 ABUNDANCES OF THE GALACTIC NUCLEI H THROUGH THE Fe GROUP FROM SATELLITE MEASUREMENTS. Cartwright, B. G.; Garcia-Munoz, M.; Simpson, J. A. (Univ. of Chicago). pp 215-20 of 12th International Conference on Cosmic Rays, Hobart, Australia. Vol. 1. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.1).

The University of Chicago instruments on the IMP-4 and IMP-5 satellites were designed to measure simultaneously with a single instrument the relative abundances of nuclei over the range Z = 1 to Z = 26 in the energy range ~20 to 300 MeV/N with individual charge resolution for all nuclei except Mn and the Fe group of nuclei. In addition, the relative abundances for the nuclei Z < 10 were measured on IMP-5 to >1000 MeV/N. The measurements confirm earlier satellite results showing that the relative abundances are energy independent to within ±20%. The determination of the odd-Z abundances between oxygen and silicon and between silicon and the iron group of nuclei makes it possible to draw conclusions regarding the charge composition of the source regions for the cosmic rays after taking account of their production in interstellar propagation. Calculations for a wide range of propagation models were made for the abundances of these two charge regions. For example, it is shown that the abundances of sodium, aluminum, and phosphorus are enriched significantly in the source relative to solar system abundances, whereas fluorine is not required in the source. (auth) (Australia)

53837 REVISED SOURCE COMPOSITION OF COSMIC RAYS FROM HYDROGEN TO NICKEL. Shapiro, M. M.; Silberberg, R.; Tsao, C. H. (Naval Research Lab., Washington, D. C.). pp 221-7 of 12th International Conference on Cosmic Rays, Hobart, Australia. Vol. 1. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From twelfth international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.1).

The primordial cosmic-ray composition was recalculated incorporating improvements in observed abundances, and in measured as well as computed cross sections. Semi-empirical relations that fit a wide range of measured cross sections permit more reliable estimates of many important unmeasured reaction rates. Feeding these into the diffusion equations yielded a path-length distribution function $e^{-0.23x}$ ($x > 1$ g/m^2), and a revised set of abundances at the source. Values are now given for H, He, and Ni, while Cr has been deleted (it is now <1% of carbon). Mg, Si, Ar, and Ca are somewhat enhanced. Trace elements at the source include: S, 4 ± 2; Ar and Ca, each 2 ± 2; Na, Al, and Ni, each 1 ± 1. The ratio R of primordial cosmic-ray to solar system abundances is plotted versus atomic number Z, and extended to include the results of Fowler et al and Price et al on the ultra-heavy nuclei. Although this graph displays a general increase of R with Z, there are appreciable departures from the monotonic trend. (auth) (Australia)

53838 CHEMICAL COMPOSITION OF COSMIC RAYS WITH Z = 3 TO 30 AT HIGH AND LOW ENERGIES. Webber, W. R.; Damle, S. V.; Kish, J. M. (Univ. of New Hampshire, Durham). pp 229-34 of 12th International Conference on Cosmic Rays, Hobart, Australia. Vol. 1. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From twelfth international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.1).

The chemical composition of cosmic rays with Z ≥ 2 was measured over an energy range from ~100 MeV/N to >2 BeV/N using 2 new large-area counter telescopes. A detailed charge spectrum is obtained at both high and low energies. Composition data was extrapolated to the cosmic ray sources using various types of interstellar path length distributions. (auth) (Australia)

53839 STUDY OF THE CHARGE SPECTRUM OF COSMIC-RAY NUCLEI. Choi, K. A.; Kim, C. O. (Korea Univ., Seoul). pp 235-40 of 12th International Conference on Cosmic Rays, Hobart, Australia. Vol. 1. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From twelfth international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.1).

Ninety-two cosmic-ray primaries, found in the 22-liter emulsion stack, flown for 13 hours at an altitude of 116,000 feet in Texas, were analyzed to determine their charges. Energies (GeV/N) were estimated from the angular distributions of nuclei fragments, and their charges from the method of delta-ray counting. Because of the size and the considerable duration of the flight time of the Texas stack, it was expected to obtain some flux of the primary cosmic rays of high energies. (auth) (Australia)

53840 CHEMICAL COMPOSITION OF HEAVY COSMIC RAY NUCLEI ABOVE 5 GeV. Casse, M. (CEA, Saclay, France); Koch, L.; Lund, N.; (and others). pp 241-5 of 12th International Conference on Cosmic Rays, Hobart, Australia. Vol. 1. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From twelfth international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.1).

Using improved instrumentation similar to that described at the 1970 COSPAR meeting, new results were obtained on the abundance ratio of elements between atomic numbers 4 and 30. (auth) (Australia)

53841 CHEMICAL COMPOSITION OF LOW ENERGY L AND M NUCLEI IN THE PRIMARY COSMIC RADIATION. Tamai, E.; Narita, N.; Sakai, T.; Ogura, K. (Nihon Univ., Chiba, Japan). pp 246-51 of 12th International Conference on Cosmic Rays, Hobart, Australia. Vol. 1. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From twelfth international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.1).

In balloon experiments flown at Fort Churchill during solar minimum, nuclear emulsion stacks were used to study the chemical composition and energy spectra of L and M nuclei in the primary cosmic rays above the atmosphere in the energy interval from 90 to 300 MeV/N. The results show a flux ratio for L to M nuclei of 0.44 in the 107 to 250 MeV/N region. The elemental structures of L and M nuclei are also reported. (auth) (Australia)

53842 CHARGE AND ENERGY SPECTRA OF HEAVY COSMIC RAY NUCLEI. Freier, Phyllis S.; Long, C. E.; Cleghorn, T. F.; Waddington, C. J. (Univ. of Minnesota, Minneapolis). pp 252-7 of 12th International Conference on Cosmic Rays, Hobart, Australia. Vol. 1. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From twelfth international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.1).

A photodensitometer technique was used to measure the charge spectrum of low-energy cosmic ray nuclei heavier than sulphur. This spectrum is mainly characterized by iron and calcium nuclei, with appreciably lesser abundances of other elements. The energy spectrum of Z ≥ 20 nuclei observed in 1968 was compared with that obtained previously in 1964. This comparison, together with a determination of the energy spectrum of helium nuclei in 1968, allows one to conclude that there is no significant charge dependence of the solar modulation. (auth) (Australia)

53843 OBSERVATION OF VH AND VVH COSMIC RAYS WITH AN IONIZATION-CHERENKOV DETECTOR SYSTEM. Binns, W. R. (McDonnell Douglas Research Labs., St. Louis); Fernandez, J. I.; Israel, M. H.; Klarmann, J.; Mewaldt, R. A. pp 260-5 of 12th International Conference on Cosmic Rays, Hobart, Australia. Vol. 1. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From twelfth international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.1).

A detector system including parallel-plate pulse ionization chambers and a Lucite Cherenkov counter, having geometry factor 0.92 m^2 ster, was operated during a series of balloon flights near 4.5 g/cm^2 atmospheric depth at geomagnetic cutoffs near 4.5 GV and 1.6 GV. Charge spectra and flux ratios are presented. The VH results are consistent with a cosmic-ray source having $J(21 \leq Z \leq 24) = 0$, and $J(20)/J(26) = .12 \pm .06$. The VVH results are consistent with the dominant mode of nucleosynthesis for these nuclei being rapid neutron capture (r-process). (auth) (Australia)

53844 COMMENTS ON THE OBSERVATION OF TRANSURANIC NUCLEI IN THE PRIMARY COSMIC RADIATION. Blanford, G. E. Jr.; Friedlander, M. W.; Klarmann, J.; (and others) (Washington Univ., St. Louis). pp 269-72 of 12th International Conference on Cosmic Rays, Hobart, Australia. Vol. 1. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From twelfth international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.1).

The results of preliminary measurements on the track of a primary cosmic-ray particle, in emulsions and plastics, indicated a possible charge of Z = 113. Further measurements and calibration showed that this particle was not relativistic within the detectors, and the best charge estimate was Z = 76 ± 4. During a total of five balloon flights, an exposure of about 10^7 m^2.ster.s. was accumulated, with no particles being detected in the charge range Z > 96. Combining this with the data reported by other workers allows estimates to be made of the flux of such particles and their abundance relative to iron nuclei. (auth) (Australia)

53845 CALCULATIONS OF CROSS SECTIONS AND THEIR APPLICATION TO COSMIC-RAY PHYSICS. Silberberg, R.;

Tsao, C. H. (Naval Research Lab., Washington, D. C.). pp 273-7 of 12th International Conference on Cosmic Rays, Hobart, Australia. Vol. 1. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From twelfth international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.1).

A knowledge of partial cross sections of nucleon-nucleus interactions is essential for the determination of (a) the primordial composition of cosmic rays on leaving the source regions, (b) the mean path length in interstellar matter, and (c) the galactic confinement time of cosmic rays. Only a few of the essential cross sections have been measured; most must be calculated by semi-empirical methods or Monte Carlo techniques. Experimental cross sections for products from proton interactions with various nuclei have been tabulated and used to formulate new empirical cross section relations. The relations are applicable to all products having a mass number $A \geq 6$, and for targets ranging from lithium to uranium. For targets with atomic number $Z \leq 30$, the relations are applicable at energies $E \geq 100$ MeV. For $6 \leq Z \leq 16$, the products with $Z \geq 6$, the standard deviation of the calculated cross sections (from the measured values) is about 20% at energies above 1 GeV, and increases to about 30% at 150 MeV; for products with $Z < 6$, it is about 30%. (auth) (Australia)

53846 STUDY OF THE SIDEREAL ANISOTROPY OF COSMIC RAYS WITH MUON TELESCOPES UNDERGROUND. Ahluwalia, H. S. (Univ. of New Mexico, Albuquerque). pp 279-83 of 12th International Conference on Cosmic Rays, Hobart, Australia. Vol. 1. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From twelfth international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.1).

The observations on the sidereal diurnal variation of the medium energy (~100 GeV) cosmic rays reported in the literature over a period of more than three decades are reviewed. These observations have been obtained with muon detectors located on the surface of the earth as well as underground. The observations seem to favor a power-law type of variational spectrum with a negative exponent of: 0.35 ± 0.28. There is considerable uncertainty as to whether there is an upper-bound on the spectrum. (auth) (Australia)

53847 INTERPRETATION OF SIDEREAL COSMIC RAY ANISOTROPIES. Swinson, Derek B. (Univ. of New Mexico, Albuquerque). pp 284-9 of 12th International Conference on Cosmic Rays, Hobart, Australia. Vol. 1. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From twelfth international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.1).

Data from giant muon telescopes at different depths underground in the northern and southern hemispheres are presented for the period 1965-1970, analyzed in sidereal time. It is observed that the phases of the sidereal anisotropies are strongly dependent on the direction of the interplanetary magnetic field, and an upper cut-off to the anisotropy appears to be indicated. Evidence for a two cycle per year modulation of the sidereal anisotropy is also presented, and its interpretation is discussed. It is concluded that no information of any astrophysical significance can be obtained about the direction of any galactic cosmic-ray anisotropy from cosmic rays of rigidity less than about 100 GV. (auth) (Australia)

53848 COMPONENTS OF THE SIDEREAL ANISOTROPY. Jacklyn, R. M. (Dept. of Supply, Melbourne); Cooke, D. J. pp 290-5 of 12th International Conference on Cosmic Rays, Hobart, Australia. Vol. 1. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From twelfth international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.1).

A method of estimating directions and energy ranges of components of the sidereal anisotropy is described. From a trial analysis using data from a prototype high-zenith-angle telescope at Mawson and the vertical underground telescopes at Hobart, there is evidence that: (a) The two-way sidereal component is of sufficiently high mean energy to allow the analysis to discriminate against an energy range appropriate to interplanetary modulation. (b) The uni-directional component is of relatively low mean energy and of variable amplitude. There may have been a reversal of the right ascension, from the value ~0600 (1958-65) to ~1800 (1968-69). (auth) (Australia)

53849 SPURIOUS SIDEREAL ANISOTROPY ARISING FROM ANNUAL MODULATION OF SOLAR DIURNAL VARIATION OF COSMIC RADIATION. Kondo, I.; Ueno, H.; Nagashima, K. (Nagoya Univ., Japan). pp 296-301 of 12th International Conference on Cosmic Rays, Hobart, Australia. Vol. 1. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From twelfth international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.1).

So far the absence of the anti-sidereal time variation has been regarded as a measure for the existence of true sidereal anisotropy of cosmic-ray intensity. This criterion, however, is found not to be effective in the following situation. When a solar anisotropy with constant magnitude and direction relative to the Sun-Earth line is present throughout the year, the daily variation observed at the Earth is modulated by the revolution of the Earth around the Sun. Such an annual modulation produces the anti-sidereal time variation comparable to the sidereal, except one special case. If, however, the anisotropy is subjected to random fluctuation around its mean value according to the variation of interplanetary space condition, the anti-sidereal time variation becomes quite small in comparison with the sidereal. Such a spurious sidereal anisotropy is characterized by its eigenphase whose value is 6 or 18 hr for the diurnal, and 0 or 6 hr for the semi-diurnal components. (auth) (Australia)

53850 SIDEREAL AND SOLAR ANISOTROPY OF HIGH-ENERGY COSMIC RAYS OBSERVED BY AN AIR CHERENKOV TELESCOPE. Sekido, Y.; Nagashima, K.; Kondo, I.; Sakakibara, S. (Nagoya Univ., Japan). pp 302-7 of 12th International Conference on Cosmic Rays, Hobart, Australia. Vol. 1. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From twelfth international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.1).

Observation of high-energy (~200 GeV) cosmic rays was continued from February 1968 to 1971, using the air Cherenkov telescope at Nagoya (35°N). Two declination bands ($\delta = 0°$ and 20°S) in the celestial sphere were scanned. The sidereal anisotropy observed at $\delta = 0°$ showed a predominant second harmonic, which is the characteristic feature of the bi-directional type proposed by Jacklyn. By these observations, this type was established as the unique empirical model of the sidereal anisotropy, and the distribution of intensities against the angle from the axis of the anisotropy was obtained from the observations (δ = 30°N, 0° and 20°S). The diurnal and semi-diurnal harmonics of the solar anisotropy obtained from these observations were similar to those of other underground observations of the same energy region. (auth) (Australia)

53851 GALACTIC MAGNETIC FIELD AND ANISOTROPY OF COSMIC RAYS ABOVE 10^{17} eV. Karakula, S. (Univ. of Durham, Eng.); Osborne, J. L.; Roberts, E.; Tkaczyk, W. pp 310-15 of 12th International Conference on Cosmic Rays, Hobart, Australia. Vol. 1. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From twelfth international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.1).

The detailed form of the anisotropy of ultrahigh-energy cosmic rays of galactic origin for given magnetic fields and source distribution is predicted from proton trajectories. Data on the arrival directions of EAS are then compared with the predicted distributions, and, assuming that metagalactic cosmic rays are isotropic, upper limits are given for the fraction of cosmic rays of galactic origin. (auth) (Australia)

53852 ARRIVAL DIRECTIONS OF LARGE AIR SHOWERS OF PRIMARY ENERGY > 10^{17} eV. Lapikens, J.; Martin, R.; Reid, R. J. O.; (and others) (Univ. of Leeds, Eng.). pp 316-20 of 12th International Conference on Cosmic Rays, Hobart, Australia. Vol. 1. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From twelfth international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.1).

The analysis of 53,733 showers detected in the period July 1966-July 1970 is now complete and is presented; new limits on the magnitude of possible anisotropies are established. More significant aspects of the present work are that, as a result of the enlarged Stage II array, and also because of improvements in the techniques of analysis of EAS, it is now possible to search for anisotropies in relatively narrow intervals of primary energy over the range 10^{17} to 10^{19} eV. Osborne and Wolfendale (private communication), in a preliminary study of the expected anisotropies for proton primaries originating in the spiral arms of the Galaxy, have used the galactic model and magnetic field configuration given by Thielheim and Langhoff (1968). They find that while the phase of the principal maximum is relatively independent of primary energy, the magnitude and detailed form of the predicted anisotropy is very energy sensitive from about 3.10^{17} eV to 5.10^{18} eV. (Australia)

53853 FLARE STAR PRODUCTION OF ENERGETIC CHARGED PARTICLES. Edwards, P. J.; McQueen, M. (Univ. of Otago, Dunedin, N. Z.). pp 323-8 of 12th International Conference on Cosmic Rays, Hobart, Australia. Vol. 1. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From twelfth international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.1).

Recent observations of solar and stellar flares are used in a reexamination of the proposal due to Unsöld (1957) that flare stars may make a substantial contribution to the galactic cosmic radiation. Flares in young convective stars of spectral type later than KO are considered. Observations of the x-ray brightness of the galactic disc indicate a negligible cosmic-ray contribution if the energetic charged particle output relative to the x-ray output is the same in stellar flares as in solar flares. (auth) (Australia)

53854 PARTICLE ACCELERATION BY WHITE DWARFS AND THE CHARGE SPECTRUM OF THE NUCLEAR COMPONENT OF COSMIC RAYS. Cowsik, R. (Univ. of California, Berkeley). pp 329-33 of 12th International Conference on Cosmic Rays, Hobart, Australia. Vol. 1. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From twelfth international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.1).

Using "pulsar mechanisms" for cosmic-ray acceleration an estimate of the rate of injection of cosmic rays by white dwarfs into the galactic volume was made showing that this is an adequate source for the observed cosmic rays. Simple models for the preferential acceleration of heavy nuclei are outlined and it is shown that a reasonable agreement with the observed charge spectrum can be achieved. The advantages and the weaknesses of the white-dwarf model for the acceleration of cosmic rays are indicated. (auth) (Australia)

53855 COSMIC RAY ELECTRONS AND THE GAMMA-RAY BACKGROUND. Cowsik, R. (Univ. of California, Berkeley). pp 334-9 of 12th International Conference on Cosmic Rays, Hobart, Australia. Vol. 1. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From twelfth international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.1).

The cosmic-ray electron spectrum is well measured in the solar neighborhood in the energy interval ~few MeV to ~few 100 GeV. The spectrum of positrons is not well known but reasonable measurements exist up to ~10 GeV. The measured spectra have been distorted by modulation by the outward flowing solar wind but there are many reasonably reliable ways for correcting these effects. Corrected spectra which represent the nature of the spectra in the interstellar space are shown. The positron flux is believed to have arisen in the decay of mesons produced in the nuclear interaction of the protons, α-particles, and other heavier nuclei in the cosmic rays. The difference between the total electron flux and the estimated flux of secondary origin gives the spectrum of the negatrons accelerated by the sources. This spectrum at injection has a slope of ~2.7 at high energies and below a few GeV falls considerably short of the intensity predicted by $\sim E^{-2.7}$. Below ~½ GeV the spectrum rolls over and one may even have a positive exponent. (auth) (Australia)

53856 POSSIBILITY OF ENERGETIC COSMIC RAYS ARRIVING FROM THE CRAB NEBULA. Osborne, J. L.; Roberts, E. (Univ. of Durham, Eng.). pp 340-3 of 12th International Conference on Cosmic Rays, Hobart, Australia. Vol. 1. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From twelfth international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.1).

Of the particles originating in the Crab supernova explosion only those whose trajectories have a length greater by 0.28 kpc than the straight line distance to the Crab will be arriving at the Earth at the present time. For a specific model of the galactic magnetic field the trajectories of protons from the Crab were calculated and it was concluded that those arriving now have energy 6.6 10^{17} eV. The absence of any observed point source sets an upper limit to the number of protons emitted with this energy of 10^{19} eV^{-1}. (auth) (Australia)

53857 ACCELERATION AND PROPAGATION OF HIGH Z COSMIC RAYS IN A PULSAR ENVIRONMENT. Balasubrahmanyan, V. K.; Ormes, J. F.; Ryan, M. J. (Goddard Space Flight Center, Greenbelt, Md.). pp 344-8 of 12th International Conference on Cosmic Rays, Hobart, Australia. Vol. 1. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From twelfth international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.1).

The survival of high Z nuclei in the x-ray photon field of a pulsar is investigated. For heavy nuclei with energies ≥100 GeV/N, 100 keV x-ray photons have sufficient energy to cause photodisintegration with cross sections of $\approx 10^{-25}$ cm^2. Using the observed properties of the Crab pulsar, extrapolation back to epochs when the pulsar was more active indicates that the photon field is sufficiently dense to prevent the acceleration of heavy nuclei in the region surrounding the pulsar. On this model, the upper limit on the energy of the escaping nuclei varies with time. The models for cosmic-ray acceleration in supernova explosions or by pulsars themselves will be related to experimental observations. (auth) (Australia)

53858 PULSARS AND THE COSMIC RAY SPECTRUM. Rengarajan, T. N. (Tata Inst. of Fundamental Research, Bombay). pp 350-3 of 12th International Conference on Cosmic Rays, Hobart, Australia. Vol. 1. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From twelfth international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.1).

Since the discovery of pulsars and their identification with rotating neutron stars, it has been recognized that these objects have sufficient energies available to contribute effectively to the observed cosmic rays. It has been shown that it is possible to accelerate particles to very high energies in the low-frequency electromagnetic field of obliquely rotating magnetic neutron stars. Some aspects of source requirements, energy spectrum, and composition of cosmic rays are investigated under the assumption that pulsars are the dominant sources of cosmic rays. The pulsar acceleration model of Ostriker and Gunn (1969), in which the relevant parameters are fixed by taking the Crab pulsar as a typical one, is used. (auth) (Australia)

53859 EXTRAGALACTIC COSMIC RAYS. Brecher, K.; Burbidge, G. (Univ. of California, San Diego, La Jolla). pp 362-6 of 12th International Conference on Cosmic Rays, Hobart, Australia. Vol. 1. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.1).

Difficulties with the galactic origin and confinement of all of the locally observed cosmic-ray heavies, electrons, and protons ($E_p \lesssim 10^{17}$ eV) are briefly presented. Evidence is presented for the existence of cosmic rays filling regions of 1 Mpc extent, and their possible sources are considered. CR propagation out of, and between galaxies is examined assuming various properties of any ambient medium. A CR model is presented involving contributions from our Galaxy, the Virgo Supercluster, and the entire Universe. (auth) (Australia)

53860 RADIONUCLIDE PRODUCTION BY COSMIC RAYS IN LUNAR ROCKS. Ito, K. (Rikkyo Univ., Tokyo); Yamamoto, H.; Okazoe, H. pp 372-6 of 12th International Conference on Cosmic Rays, Hobart, Australia. Vol. 1. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From twelfth international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.1).

Measurements of the concentration of long-lived radionuclides in lunar rocks are of great use for studying the secular variations of solar and galactic cosmic rays. The depth variations of specific activities of such species as 7.4×10^5 yr ^{26}Al, 1.9×10^6 yr ^{53}Mn, and 2.5×10^6 yr ^{10}Be are rated. If lunar rocks have been at rest and no erosion had occurred over a long period of time, it would be suggested that galactic cosmic-ray intensity of 10^{6-7} years ago was about twice to three times as large as that now observed. (auth) (Australia)

53861 COSMIC RAY PROPAGATION AND SOURCE DISTRIBUTION. Lingenfelter, R. E. (Univ. of California, Los Angeles); Ramaty, R. pp 377-82 of 12th International Conference on Cosmic Rays, Hobart, Australia. Vol. 1. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From twelfth international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.1).

The effects of the source distribution and propagation on the cosmic-ray composition and anisotropy were investigated using a statistical discrete source distribution for primary cosmic-ray sources in the galactic disk and a continuous and time independent distribution for secondary particles. For cosmic-ray propagation by 3-dimensional diffusion in a confinement volume with absorbing boundaries the observed fragmentation product abundances and anisotropy were found to require a mean free path <0.1 pc; while with reflecting boundaries, the fragmentation depended principally on the escape probability at the boundary and was almost independent of the mean free path. For compound diffusion, the fragmentation and anisotropy required a character-

istic length in the 3-dimensional random magnetic field of ~30 pc, a mean free path for 1-dimensional diffusion along field lines <30 pc, and the escape time from the confinement volume of about 2×10^7 years. (auth) (Australia)

53862 EFFECT OF IONISATION LOSS ON THE ENERGY SPECTRA OF COSMIC RAY NUCLEI UNDERGOING FERMI ACCELERATION. Ramadurai, S. (Tata Inst. of Fundamental Research, Bombay). pp 384-9 of 12th International Conference on Cosmic Rays, Hobart, Australia. Vol. 1. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From twelfth international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.1).

New analytical expressions are derived taking into account the velocity dependence of the rate of energy gain in the Fermi acceleration process which was neglected earlier. The resulting spectra indicate the pile up of nuclei near their critical energy for acceleration. The shapes of the energy spectra after acceleration are different, for various types of nuclei, the higher the charge the steeper being the spectra. This result differs quantitatively from the earlier result. The critical energies of acceleration of the same nuclei for the same acceleration parameters are higher than the ones derived earlier. (auth) (Australia)

53863 SCATTERING OF HIGHER ENERGY COSMIC RAYS. Melrose, D. B. (Australian National Univ., Canberra). pp 390-4 of 12th International Conference on Cosmic Rays, Hobart, Australia. Vol. 1. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From twelfth international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.1).

Pitch-angle scattering of cosmic rays by hydromagnetic waves generated by the cosmic rays themselves is ineffective for $E \gtrsim 10^{11}$ eV. Scattering and the associated parallel diffusion due to waves already present is discussed with particular reference to a model for confinement and escape. The required spectrum is derived and the presence of the required waves is discussed. (auth) (Australia)

53864 EFFECT OF GALACTIC MAGNETIC FIELD LINE WANDERING ON COSMIC-RAY PARAMETERS. Jones, Frank C. (Goddard Space Flight Center, Greenbelt, Md.). pp 396-400 of 12th International Conference on Cosmic Rays, Hobart, Australia. Vol. 1. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From twelfth international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.1).

The local configuration of the galactic magnetic field is an important factor in determining local cosmic-ray parameters such as density, mean age, and streaming velocity. According to the theory of Jokipii and Parker the flux tube that confines the cosmic rays seen at Earth undergoes a random wandering about the average field direction. It continues this wandering until it reaches a distance sufficiently far from the central plane of the Galaxy such that the bubble blowing instability occurs and it thus comes to an end as a container of cosmic rays. In a previous paper a probability density for the end points of the flux tube passing through the Earth was calculated employing the theory of Gaussian processes. This result is used to calculate the probability densities of the cosmic-ray parameters based on a smoothed out source, one dimensional diffusion model. It is seen that these parameters have a very wide range of fluctuation but that even when the mean age is confined to a narrow range the mean and most probable value of the streaming velocity is zero. From this it is argued that a very small observed value for the cosmic-ray anisotropy requires no special explanation any more than would any other value compatible with the probability distribution. (auth)

53865 MECHANISM FOR CONFINEMENT OF COSMIC RAYS IN THE GALAXY. Jokipii, J. R. (California Inst. of Tech., Pasadena). pp 401-6 of 12th International Conference on Cosmic Rays, Hobart, Australia. Vol. 1. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.1).

Various mechanisms for confinement of cosmic rays in the Galaxy are discussed. The simple diffusion model faces difficulties because the small scattering mean-free-paths required imply a very high rate of Fermi acceleration. Diffusive confinement by self-excited waves does not have this problem but has others. It is concluded that present evidence argues against diffusive confinement of cosmic rays and in favor of confinement mechanisms, such as the "leaky box," which rely on the overall topology of the galactic magnetic field or on processes taking place at the boundary of the confinement region. (auth) (Australia)

53866 SOME COSMIC EFFECTS OF THE FINITE REST-MASS OF THE WAVE QUANTUM. Cole, Keith D. (La Trobe Univ., Bundoora, Australia). pp 408-13 of 12th International Conference on Cosmic Rays, Hobart, Australia. Vol. 1. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From twelfth international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.1).

A quantum of wave energy in a medium can be considered to be a particle in a vacuum with rest-mass determined by the dispersion relationship of waves in the medium, the de Broglie relationships, and the theory of special relativity. In a simple plasma the rest-mass of radio frequency photons is $h \nu_p/c^2$ where ν_p is the plasma frequency. Treating the photon in a plasma as a particle in vacuum the dynamical equations are solved for the case of a plasma surrounding a massive celestial object. A new component of the bending radio-wave trajectories in a gravitational field is found. This is distinct from Einstein's bending of light rays. For a star like the Sun the bending is $\nu_p/4(\nu-\nu_p)$ times that for light in vacuo. In more massive objects like pulsars the bending is enormous and must be evaluated numerically. An expression for the gravitational redshift, which reduces in the proper conditions to the well-known Einstein formula, is found. It is shown that a prerequisite for photon-photon interaction is that the phase velocity should exceed c. (auth) (Australia)

53867 SUPERHEAVY ELEMENTS IN COSMIC RAYS. Peaslee, D. C. (Australian National Univ., Canberra). pp 419-22 of 12th International Conference on Cosmic Rays, Hobart, Australia. Vol. 1. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From twelfth international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.1).

Two facts suggest the same mean age, $t_{SH} \sim 10^5$ yrs, for superheavy cosmic-ray primaries: the cosmic-ray abundance of elements with $Z > 83$, and the upper limit of observed charge number, $Z \approx 96$. These features also suggest that the generating r-processes are efficient enough to produce the island of stability at $Z \simeq 114$, if it exists. (auth) (Australia)

53868 THEORY OF NARROW-ANGLE COSMIC RAY ANISOTROPIES. Barrowes, S. C. (Univ. of Utah, Salt Lake City). pp 423-8 of 12th International Conference on Cosmic Rays, Hobart, Australia. Vol. 1. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From twelfth international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.1).

A theory of cosmic-ray anisotropies is described, based upon a fairly smooth galactic magnetic field and rotating magnetic neutron stars or white dwarfs as cosmic-ray sources. If there are few small-scale irregularities in the galactic magnetic field, so that scattering of cosmic rays is unimportant for distances within 10,000 l y, then during sunspot minima a narrow-angle anisotropy should probably be observable at low energies ($E \leq 10^{12}$ eV). Such anisotropies were observed during the last two sunspot minima in 1952-56 and 1964. On the basis of theory and previous experience, an anisotropy may be anticipated in 1973-75 if adequate experiments are being done to observe it. (auth) (Australia)

53869 EXPLANATION OF THE BREAK IN THE PRIMARY SPECTRUM. Barrowes, S. (Univ. of Utah, Salt Lake City). pp 429-31 of 12th International Conference on Cosmic Rays, Hobart, Australia. Vol. 1. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From twelfth international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.1).

The acceleration of cosmic rays in pulsars should be capable of producing cosmic rays of energy up to 10^{21} eV. These will be absorbed in the envelope of the supernova however, unless sufficient time is allowed for the shell to become thin. For a typical pulsar, the roughly calculated energy cutoff is 3×10^{16} eV. Unknown factors might well bring this number down, thus explaining the break in the primary cosmic-ray spectrum at 3×10^{15} eV without reference to any sharp energy dependence for leakage of cosmic rays from the Galaxy. (auth) (Australia)

53870 CHANGE IN THE ELEVEN-YEAR MODULATION AT THE TIME OF THE JUNE 8, 1969, FORBUSH DECREASE. Lockwood, John A.; Lezniak, Jerry A.; Webber, William R. (Univ. of New Hampshire, Durham). J. Geophys. Res.; 77: No. 25, 4839-44(1 Sep 1972).

The functional form of the modulation for the 11-year variation changed abruptly after the Forbush decrease of June 8, 1969. This change in the 11-year modulation suggests that this Forbush decrease was an integral part of the 11-year variation. Some details

of the change as observed by neutron monitors and by spacecraft at low energies are discussed. (auth)

Stars

Refer also to abstracts 53853, 53854, 53940, 53986, 54404, and 54663.

53871 PULSATING VARIABLES IN THE PLEIADES CLUSTER. Breger, Michel (State Univ. of New York, Stony Brook). Astrophys. J.; 176: No. 2, 367-71(1 Sep 1972).

Thirty-one B and A stars in the Pleiades cluster were tested for short-period variability. Five δ Scuti stars and one Be Shell variable were detected. The pulsation periods under 1 hour for the stars on the zero-age main sequence are predicted by the period–density relation. The period of 34 minutes for TR 51 is the shortest known so far for Cepheid-like pulsation. The new variables extend the hot border of the instability strip to spectral type A2 on the zero-age main sequence. (auth)

53872 MAIN-SEQUENCE PULSATION IN OPEN CLUSTERS. Breger, Michel. (State Univ. of New York, Stony Brook). Astrophys. J.; 176: No. 2, 373-80(1 Sep 1972).

Studies of short-period pulsation in open clusters show that pulsation occurs in clusters of all ages provided stars are present in the instability strip (A2 V–F0 V). This includes pre–main-sequence stars. The value of the pulsation constant Q is similar in the clusters studied, i.e., $\langle Q \rangle = 0.026$ days. This points toward pulsation in the first overtone. About 30% of the main-sequence cluster stars inside the instability strip show detectable variability. Hyades-type stars may show a particularly high incidence of pulsation, possibly connected to a high helium abundance. Statistically extremely significant correlations between slow rotation, metallicity, and pulsational stability are established for different clusters. The observed relations can be explained by a diffusion hypothesis: (i) Slowly rotating A dwarfs usually possess extreme stability in some subsurface zones which causes element segregation. This leads to metallicism as well as increased pulsational stability because of the low helium content in the critical He II ionization zone. (ii) Low rotation, however, is not a sufficient condition to cause metallicism. Some examples are given. These slow rotators may, and often do, pulsate. (iii) Dwarfs with rotational velocities greater than ~100 km s^{-1} may pulsate and do not become Am stars. These stars, however, are so close to stability that less than 50% have detectable variability. (auth)

53873 CONSISTENT MODEL OF THE PLANETARY NEBULA NGC 7662. Kirkpatrick, Ronald C. (Texas A and M Univ., College Station). Astrophys. J.; 176: No. 2, 381-93 (1 Sep 1972).

A numerical model of NGC 7662 was computed which very closely matches the observations. It was found that in order to obtain a model which is consistent with all of the observed line strengths and line ratios, one must take into account not only the double-shell structure but also the contribution of condensations in the nebula and the departure of the central-star flux distribution from that of a black-body. The distance, mass, and reddening correction derived by coupling this model with the Hβ and radio flux measurements should be fairly reliable. Also, the abundances deduced for helium, oxygen, neon, and argon should be reasonably well determined. (auth)

53874 RELAXATION OSCILLATIONS IN THE ENVELOPES OF LUMINOUS RED GIANTS. Smith, Richard L.; Rose, William K. (Massachusetts Inst. of Tech., Cambridge). Astrophys. J.; 176: No. 2, 395-403(1 Sep 1972).

The envelopes of luminous red-giant stars have thermal timescales that are nearly as short as their dynamical timescales. The expansion of such an envelope is readily reversed and a collapse phase initiated as a result of large radiative losses. Numerical hydrodynamic calculations are described which indicate that high radiation-pressure gradients at the base of the envelope, resulting from thermal instability in the core, are capable of driving envelope relaxation oscillations. Instability to nonadiabatic pulsations may provide yet another mechanism for driving envelope oscillations, but this mechanism has not been fully investigated. Relaxation oscillations in the envelope are found to produce strong shock waves that appear capable of causing rapid mass loss in sufficiently luminous red giants. The calculations suggest that planetary nebulae may result from the final phase of mass loss on the red-giant branch. (auth)

53875 INTERSTELLAR LINES IN THE ULTRAVIOLET SPECTRUM OF ZETA OPHIUCHI. Smith, Andrew M. (Goddard Space Flight Center, Greenbelt, Md.). Astrophys. J.; 176: No. 2, 405-23(1 Sep 1972).

Interstellar lines arising in C^0, C^+, O^0, Si^+, and S^+ observed in the ultraviolet spectrum of ζ Oph by rocket spectrographic techniques were analyzed. The main results were that within a factor of 10 the abundances of C^+, O^0, and Si^+ outside the H II region surrounding ζ Oph relative to the hydrogen abundance were equal to solar values. The lines in C^0 and S^+ implied that the interstellar matter is distributed among several clouds as indicated by high-resolution visible spectra. The $^2P^0_{\frac{1}{2}}$ (0.0079 eV) fine-structure level of the ground-state configuration in C^+ was strongly populated, the abundance ratio of the $^2P^0_{\frac{1}{2}}$ level to the $^2P^0_{\frac{3}{2}}$ ground level being 1.5. It is suggested that the excited C^+ ions are inside the Strömgren sphere where proton densities equal to or greater than 220 cm^{-3} can collisionally excite the ions at sufficient rates. Stellar absorption lines of C IV (1548.2, 1550.8 Å) and Nv (1238.8, 1242.8 Å) were seen shifted to lower wavelengths, indicating stellar mass loss. The stellar material will be stopped in the H II region by Coulomb forces, and it is suggested that most of the C^+ ions in the $^2P^0_{\frac{1}{2}}$ level comes from this source. (auth)

53876 MAGNETIC-FIELD VARIATIONS IN 78 VIRGINIS, BETA CORONAE BOREALIS, AND 73 DRACONIS. Wolff, Sidney C.; Bonsack, Walter K. (Univ. of Hawaii, Honolulu). Astrophys. J.; 176: No. 2, 425-32(1 Sep 1972).

Photographic observations of the Zeeman effect in stellar spectra were made with new equipment at the Mauna Kea Observatory. Measurements of the effective longitudinal field H_e were obtained for 78 Vir, β CrB, and 73 Dra. Comparison of the values obtained for 78 Vir and β CrB with the measurements made by Preston at Lick Observatory established the absence of any significant systematic difference between the two observatories. The results do not support the suggestion of long-term systematic changes in the cycles of magnetic variation of β CrB and 73 Dra, which were marginally indicated by previous investigations. (auth)

53877 PERIODIC VARIABILITY OF THE PECULIAR A STAR HD 111133. Wolff, Sidney C.; Wolff, Richard J. (Univ. of Hawaii, Honolulu). Astrophys. J.; 176: No. 2, 433-8(1 Sep 1972).

The period of the peculiar A star HD 111133 is 16.31 days. Maximum light coincides in phase with minimum longitudinal magnetic field. The strengths of the lines of the iron-peak elements vary and are greatest at maximum light. This star belongs to that subgroup of Ap stars in which the magnetic and rotation axes are nearly aligned. (auth)

53878 TRANSFER OF RESONANCE-LINE RADIATION IN DIFFERENTIALLY EXPANDING ATMOSPHERES. I. GENERAL CONSIDERATIONS AND MONTE CARLO CALCULATIONS. Caroff, Lawrence J.; Noerdlinger, Peter D.; Scargle, Jeffrey D. (Ames Research Center, Moffett Field, Calif.). Astrophys. J.; 176: No. 2, 439-61(1 Sep 1972).

A Monte Carlo method is given for analyzing the transfer of resonance radiation in a rapidly and differentially expanding nebula. Coherence in the frame of the atom is shown to lead to interesting modifications of the emergent radiation field, as compared with the other more usual assumptions of coherence or redistribution in the fluid frame. Results are presented in tabular form suitable for further use. Sample line profiles produced by pure scattering out of the continuum are generated, and it is shown that an arbitrarily high peak can be obtained. This conclusion is independent of the coherence assumption used. The distribution of the number of scatterings is found in all cases. An analytic solution is presented for the case of coherence in the fluid frame. (auth)

53879 TRANSFER OF RESONANCE-LINE RADIATION IN DIFFERENTIALLY EXPANDING ATMOSPHERES. II. ANALYTIC SOLUTION FOR THE CASE OF COHERENCE IN THE FRAME OF THE FLUID. Noerdlinger, Peter D. (Ames Research Center, Moffett Field, Calif.); Scargle, Jeffrey D. Astrophys. J.; 176: No. 2, 463-78(1 Sep 1972).

An exact solution is obtained for the problem of line transfer by resonant scattering (assumed coherent in the fluid frame) in a differentially expanding atmosphere. The probabilistic method developed is a generalization of the method of addition of layers plus a decomposition of the radiation field into partial radiation fields due to those photons that scatter exactly n times before escaping (n = 0, 1, 2, 3, . . .). Generalization to finite destruction probability per scattering is immediate, allowing treatment of nonresonance lines such as Lβ. Some results of interest for the theory of expanding stellar atmospheres are presented graphically. (auth)

53880 SYNTHESIS OF COMPOSITE SPECTRA: A STUDY OF FOUR GLOBULAR CLUSTERS OF THE GALAXY, FIVE GLOBULAR CLUSTERS OF M31, AND THE NUCLEUS OF NGC 205. Christensen, Clark G. Pasadena, Calif.; California Inst. of

Tech. (1972). 221p. University Microfilms Order No. 72-22,546.

Thesis.

A spectral synthesis technique similar to that of Spinrad and Taylor (1971) was applied to the integrated light of globular clusters M5, M13, M15, and M92 of the Galaxy; H12, H55, H140, B282, and MIV of M31; and to the nucleus of the elliptical galaxy NGC 205. The derived stellar contents of the four local clusters were compared with color–magnitude diagrams and luminosity functions based on studies of individual stars within these systems. Results agree. The technique yields information on both the metal content of clusters and their horizontal-branch colors and thus is useful for extracting the two parameters which apparently describe galactic globular clusters. Principal results of the study of the six extragalactic systems are listed. (TSS) (Diss. Abstr. Int., B)

53881 STUDY OF THE UNIDENTIFIED INTERSTELLAR DIFFUSE FEATURES. Wu, Chi-Chao. Madison, Wis.; Univ. of Wisconsin (1972). 56p. University Microfilms Order No. 72-19,017.

Thesis.

The interstellar diffuse lines λλ5780, 5797 were observed in 66 stars using the Washburn Observatory echelle spectrograph coupled with an image tube. At a resolution of 0.17Å, the profiles of these diffuse lines are asymmetric and steeper to the blue. There is also a broad, shallow feature shortward of λ5780. Equivalent widths of λλ5780, 5797 were measured from tracings which had a resolution of 0.26Å. The unlikelihood and/or difficulties of the following models for diffuse interstellar features are also discussed: (1) molecular processes, (2) shifted and broadened resonance lines of atomic and molecular impurities in solids. (3) F-centers in alkali halides, and (4) plasma oscillations in solids. (TSS) (Diss. Abstr. Int., B)

53882 STUDY OF TWENTY-ONE SHARP-LINED NON-VARIABLE COOL PECULIAR A STARS. Adelman, Saul Joseph. Pasadena, Calif.; California Inst. of Tech. (1972). 371p. University Microfilms Order No. 72-22,597.

Thesis.

Elemental abundance analyses were performed for twenty-one cool Ap stars, also known as SrCrEu stars, which are not known to be spectrum variables and whose projected rotational velocity is not greater than 10 km/sec. Zeeman and thermal Doppler broadening are the basic line intensification mechanisms considered. Effective temperatures estimated initially from UBV photoelectric data were modified by requiring that the iron abundances derived from both neutral and singly-ionized lines be equal. Log g was assumed to be 4.0. In addition, two normal stars were included for comparison. (TSS) (Diss. Abstr. Int., B)

53883 MEMBERSHIP IN THE EXTREMELY YOUNG OPEN CLUSTER NGC 6530 (M8). van Altena, W. F. (Univ. of Chicago); Jones, B. F. Astron. Astrophys.; 20: No. 3, 425-36(Sep 1972).

Relative proper motions for 363 stars in the vicinity of the extremely young open cluster NGC 6530 (M8) were determined from plates taken with the Yerkes Observatory 40-inch refractor. Based on these relative proper motions, which had an average mean error of $\pm 0.0006''$/yr, probabilities of membership were determined with the result that of the 363 stars measured there were 76 expected members. The average reddening was found to be 0.35 mag with little scatter. Adopting the ratio of total to selective absorption to be 3.0, a corrected distance modulus of 11.25 mag or a distance of 1780 pc was found. An age for the cluster of 2×10^6 yr was determined based on the theoretical gravitational contraction isochrones of Iben, although the observations were perhaps fit slightly better by the ^{3}He main sequence of Ulrich. The two yellow stars suggested as possible giant members of the cluster by Walker, as well as the five brightest red stars found by Blanco and Grant, had zero probabilities of membership. Five probable nonmembers were suspected of being variable in light. Of the six Hα emission line stars found by Herbig, three were probable members. The two bright O stars, HD 164794 and HD 165052, had negligible relative proper motions. From an analysis of their proper motion errors, a minimum expansion age of 0.6×10^6 yr was derived, in agreement with the gravitational contraction age of 2×10^6 yr for the cluster. Herschel 36, the exciting star for the "hour glass" nebula, is possibly a cluster member. (auth)

53884 VARIABLE STARS OF SMALL AMPLITUDE I: SUPERGIANTS AND OB STARS. Maeder, A.; Rufener, F. (Observatoire, Geneva). Astron. Astrophys.; 20: No. 3, 437-43(Sep 1972).

The light variability of various kinds of stars is discussed, by means of 5000 measurements of color-indices made for 660 stars. These stars were observed in the Geneva Observatory photometric system; they were not measured for this purpose and they belong to various programs. The Am stars were found to be nonvariable in agreement with Breger's results (1970). The Ap stars were variable in agreement with Preston's results (1971). All the red giants of type K5 III and later may be suspected of variability. The case of supergiants and OB stars is considered. For the supergiants of type B3–G8, it was found that: (1) All the Ia supergiants are variable in light with an amplitude in color index of about 0.02 to 0.04 in.; for the Ib supergiants, a large fraction, if not all, also showed variability. (2) An amplitude–luminosity relation exists in the sense of the largest amplitudes for the brightest stars. (3) Some arguments are given which suggest that, besides the mass loss, at least a part of these variations may be due to an oscillatory mechanism. For the OB stars, it was found that: (1) A large fraction of OB stars show photometric variations. (2) A very striking concentration of stars with large dispersion of their color indices (amplitude $\sim 0.4^m$) appears for very high T_{eff} and luminosity. (3) These stars occur in an area of the HR diagram, where there exist much theoretical and uv or visible spectroscopic evidence of mass loss. (auth)

53885 EFFECTS OF SEMICONVECTION ON THE HORIZONTAL-BRANCH. Sweigart, A. V.; Demarque, P. (Yale Univ. Observatory, New Haven). Astron. Astrophys.; 20: No. 3, 445-53 (Sep 1972).

The effects of semiconvection on the horizontal-branch evolution of a 0.60 $M_\odot$ Population II star with the envelope composition parameters X = 0.732 and Z = 0.001 are investigated. Following an initial phase of convective-core overshooting the models form a semiconvective zone which at its maximum extent results in the depletion of helium out to a mass value of 0.25 $M_\odot$. A comparison between sequences computed with and without a treatment of semiconvection indicates that the neglect of semiconvection will (a) reduce the length of the horizontal-branch track by a factor of 1.8 and (b) decrease the horizontal-branch lifetime by a factor of 1.9. A number of additional horizontal-branch sequences including a treatment of semiconvection are presented over the mass range from 0.51 to 0.65 $M_\odot$. These sequences suggest that a mass spread on the order of 0.05 $M_\odot$ would be sufficient to produce a dispersion of 0.30 in log T_{eff} over the log T_{eff} interval from roughly 3.70–4.15. (auth)

53886 CONDITIONS FOR HOMOGENEOUS STELLAR MODELS TO HAVE ONLY REAL SECULAR EIGENVALUES. Gabriel, M.; Noels, A. (Univ., Liege). Astron. Astrophys.; 20: No. 3, 455-9 (Sep 1972).

The conditions to have only real eigenvalues in the secular spectrum of homogeneous stars are discussed numerically. Results suggest that they are identical to those for the existence of a nearly homologous solution as an eigensolution. When one deviates enough from these conditions, complex eigenvalues are generally present except when very special conditions on the opacity and energy generation laws are fulfilled. (auth)

53887 ULTRAVIOLET ABSORPTION LINES IN THE SPECTRUM OF VEGA. Gurzadyan, G. A.; Ohanesyan, J. B. (BAO, Erevan). Astron. Astrophys.; 20: No. 3, 321-4(Sep 1972).

Ultraviolet spectrograms of Vega, covering the wavelength 2000 to 3800 Å, are presented. More than ten ultraviolet absorption lines and bands were detected and identified. The strongest line was the resonance doublet of ionized magnesium—2802.7 Mg II and 2795.5 Mg II, with an equivalent width of 3 Å. All the other absorption lines or bands (blended lines) are produced by metals, mainly neutral and ionized iron and nickel. Using the results of other space observations of three stars—γ Cas (B 0.5), Canopus (F 0) and Sun (G 1)—a markedly distinctive dependence between the equivalent width of the doublet 2800 Å Mg II and the spectra class of the star was established. This relationship can be used, in particular, to make an accurate spectral classification of stars. (auth)

53888 QUANTITATIVE ANALYSIS OF γ CAPRICORNI. Selvelli, P. L. (Astronomical Observatory, Trieste, Italy). Astron. Astrophys.; 20: No. 3, 325-32 (Sep 1972).

A quantitative analysis of the transition star γ Cap was made in order to investigate the reasons of the disagreement among its chemical-physical parameters derived by previous researches. The analysis by the differential curve of growth method relative to 30 L Mi and 63 Tau, which have about the same θ_{eff} and log g, indicated that γ Cap has characteristics common to the Am stars: deficiencies of calcium and scandium and overabundances by factors around 10^2 of heavy elements and rare earths. The values of the microturbulence range between 3.1 and 6.4 km/s. A strong systematic difference arises from the comparison between the values of the equivalent widths found in this work and in the previous analysis. Moreover the curves of growth of γ Cap

in the blue and red spectral regions (from spectrograms taken at different epochs) give abundance differences for Ti, Cr, Ni, Y, beyond the order of the experimental errors. This fact suggests that γ Cap is spectrum variable in spite of the similarity that γ Cap presents with the Am star groups. (auth)

53889 INFRARED PHOTOMETRY OF NORTHERN WOLF–RAYET STARS. Allen, D. A. (Carnegie Inst., Washington, D. C.); Swings, J. P.; Harvey, P. M. Astron. Astrophys.; 20: No. 3, 333-6(Sep 1972).

Observations of Wolf–Rayet stars were made at 1.6 and 2.2 μ. The [2.2 μ]–[1.6 μ] colors were found to be systematically greater in WC than in WN stars. (auth)

53890 EQUIVALENT WIDTH OF INTERSTELLAR MOLECULAR LINES. II. CO, SiO, CS, H_2, AND HD IN THE INTERSTELLAR SPECTRUM OF ζ PERSEI. Krishna, Swamy, K. S.; Tarafdar, S. P. (Tata Inst. of Fundamental Research Bombay). Astron. Astrophys.; 20: No. 3, 341-5(Sep 1972).

Analysis of the measured equivalent widths of the Lyman band of H_2 by Carruthers for the star ζ Per, gives $n(H_2) \approx 10^{21}$ cm^{-2}. It appears that the density of H_2 is larger than that of H in the direction of ζ Per. Calculation of the equivalent widths of the lines of the bands (C–X) of H_2 and (B–X) and (C–X) of CO and HD reveal that they may be observable shortward of 1150 Å. (auth)

53891 EXTENDED HORIZONTAL BRANCH LOCI. Caloi, Vittoria (Laboratorio de Astrofisica Spaziale, Frascati, Italy). Astron. Astrophys.; 20: No. 3, 357-60(Sep 1972).

Models for extremely blue horizontal branch type stars are presented. An interpretation of B subdwarfs in the halo is attempted in terms of these models. The importance of reliable determinations of the luminosities of these objects for indications about the original He-content is stressed. (auth)

53892 ABUNDANCES OF NOBLE GASES IN EXTREME POPULATION I MATTER AND THE SUN. Scholz, M. (Univ., Heidelberg). Astron. Astrophys.; 20: No. 3, 465-7(Sep 1972).

Recent abundance determinations in extreme Population I matter on the one hand and the Sun on the other indicate that helium has about the same abundance but neon and argon are enhanced in young objects. (auth)

53893 STELLAR ENERGY-LOSS RATES IN A CONVERGENT THEORY OF WEAK AND ELECTROMAGNETIC INTERACTIONS. Dicus, Duane A. (Univ. of Rochestester, N. Y.). Phys. Rev., D; 6: No. 4, 941-9(15 Aug 1972).

The stellar energy-loss rates due to the production of neutrino pairs are calculated in Weinberg's theory of electromagnetic and weak interactions. The ratio of the total rate calculated here to the rate calculated in the ordinary theory of weak interactions is $10^{0}{}^{+2}_{-1}{}^{.8}_{.0}$, where the uncertainty comes entirely from the lack of knowledge of the W-meson mass. The ratio of the experimental rate to the rate calculated in the ordinary theory is $10^{0 \pm 2}$. Thus Weinberg's theory gives numbers well within the experimental limits for all values of the W mass. (auth)

53894 STABILITY OF NONRADIAL VIBRATIONAL MODES OF RELATIVISTIC NEUTRON STARS. Cazzola, P. (Univ., Ferrara, Italy); Lucaroni, L. Phys. Rev., D; 6: No. 4, 950-6 (15 Aug 1972).

An analytical connection is established between the amplitudes of gravitational waves scattered by a relativistic neutron star and its nonradial vibrational modes. The procedure is similar to the one followed by Jost and other authors who recognized that the bound-state Schroedinger wave functions in potential theory are analytically connected with the S function for the scattering. In the case of potential theory, the S function for the scattering is analytic in the wave number k, except for singular points or branch lines. The resonant and antiresonant states are represented by poles of S in the lower half Gauss k plane. The bound states, on the other hand, correspond to poles on the positive imaginary axis. Similarly, in the case of a neutron star the amplitudes of gravitational waves scattered by the star are shown, in the present paper, to be analytic in the wave circular frequency ω. The stable and unstable vibrational modes of the neutron star give rise to resonances in the scattering of gravitational waves described by poles of scattering amplitude lying, respectively, in the upper and lower half Gauss ω plane. In particular, a result is obtained (similar to Levinson's theorem for potential scattering) which relates the unstable modes to scattering phase shifts. (auth)

53895 OBSERVATIONS OF RAPID BLUE VARIABLES. VII. EX HYDRAE. Warner, Brian (Univ. of Texas, Austin). Mon. Notic. Roy. Astron. Soc.; 158: No. 4, 425-30(1972).

Photometric observations of EX Hya with time resolutions of 2 and 5 s are reported. EX Hya is very active on time scales of 10 to 100 s. A comparison with WZ Sge is made. It is suggested that the x-ray source 2ASE 1253-28 may be identified with EX Hya. (auth)

53896 STRUCTURE AND EVOLUTION OF HELIUM STARS. Dinger, Ann St. Clair (Northwestern Univ., Evanston, Ill.). Mon. Notic. Roy. Astron. Soc.; 158: No. 4, 383-403(1972).

Numerical models of helium stars were constructed in an effort to fit the models to the observed extreme-helium stars, i.e., those which have equivalent spectral types of O7 to B5, absolute magnitudes brighter than –1.6, and weak or missing hydrogen lines. Main-sequence models of 1, 2, 4, and 8 $M_\odot$ were computed for Y = 0.98, Z = 0.02. The effect of the inclusion of the $^{14}N(\alpha,\gamma)^{18}F$ $(e^+\nu)^{18}O$ reaction was investigated. It is shown that the addition of 10^{-3} of hydrogen by mass had a negligible effect on these models. One-solar-mass models with 2, 6, 14, 30, and 58% additional carbon were also computed. Carbon enrichment increased the luminosity, effective temperature and central temperature of the model and decreased the central density. A four-solar-mass model with Z = 0.60 (0.02 solar metals and 0.58 additional carbon) was also computed. The four-solar-mass Z = 0.02 and Z = 0.60 models were evolved until carbon ignited in their cores under nondegenerate conditions. The evolution of the one-solar-mass, Z = 0.60 model was followed to the white dwarf state. Computations of the evolution of the one-solar-mass, Z = 0.02 model were stopped when the mass of the helium-exhausted core was 0.767 $M_\odot$. This model crossed the main sequence for hydrogen-burning in the region of the observed helium stars and evolved towards the red giant region of the H–R diagram. (auth)

53897 ABSORPTION SPECTRA OF TYPE II SUPERNOVAE. Patchett, Bruce; Branch, David (Royal Greenwich Observatory, Hailsham, Eng.). Mon. Notic. Roy. Astron. Soc.; 158: No. 4, 375-82(1972).

On the basis of wavelength coincidence and comparison of observed and synthetic spectra, intensity minima in Type II supernova spectra are attributed to blueshifted absorption lines of hydrogen and Fe II. (auth)

53898 STELLAR COMPOSITIONS FROM NARROW-BAND PHOTOMETRY. III. IRON ABUNDANCES IN A FURTHER 120 EVOLVED STARS. Williams, P. M. (Cambridge Univ., Eng.). Mon. Notic. Roy. Astron. Soc.; 158: No. 4, 361-73 (1972).

Using narrow-band indices observed with the Cambridge spectrophotometer and analyzed using synthetic spectra computed from model atmospheres, the iron abundances of a further 120 evolved stars were determined. The results compare well with those from high-dispersion spectroscopic analyses. A number of super-metal-rich stars were isolated, including three high-velocity stars lying below the M67 subgiant branch in the H–R diagram. (auth)

53899 V_{553} CENTAURI. A TYPE II CEPHEID WITH AN OVERABUNDANCE OF CARBON. Evans, T. Lloyd (Radcliffe Observatory, Pretoria); Wisse, P. N. J.; Wisse, M. Mon. Notic. Roy. Astron. Soc.; 159: No. 1, 67-78(1972).

The Cepheid V553 Centauri (P = 2.06d) has strong C_2, CH, and CN bands in its spectrum. These show a pronounced variation with phase, being strongest at minimum light. Their presence implies a considerable overabundance of carbon in the star's atmosphere. The radial velocity curve shows a phase lag similar to that of other Cepheids. The radial velocity is –6km s^{-1}. The light and color curves show the characteristic features of a globular cluster Cepheid of this period. RT TrA (P = 1.95d), for which fragmentary data are available, is very similar. V553 Cen and RT TrA probably belong to the disk rather than the halo population. Theory predicts an excess of carbon in the atmospheres of some of the longer period Type II Cepheids. The possibility that V553 and RT TrA are related to the Cepheids found in dwarf spheroidal galaxies, which are confined to short periods, is discussed. (auth)

53900 NON-LTE ANALYSIS OF THE O-TYPE SUBDWARF, HD 49798. Dufton, P. L. (Observatories, Cambridge, Eng.). Mon. Notic. Roy. Astron. Soc.; 159: No. 1, 79-93(1972).

Equivalent width and line profile data are presented for the O-type subdwarf, HD 49798. These observations cannot be explained on the assumption of LTE. Comparison with the results of non-LTE calculations produces the atmospheric parameters T_{eff} = 45000 ± 5000°K (from the Balmer discontinuity) and log a = 4.3 ± 0.3 (from the Hγ profile). The ionized helium line wings are considerably stronger than the non-LTE calculations predicted with "normal" abundances and this is interpreted as evidence of a

helium overabundance by a factor of five. An approximately solar mass is deduced for the primary using the absolute magnitude, M_v, of -0.2 ± 1.0m found from the interstellar calcium K line strength. The star is a spectroscopic binary. Assuming the rotation of the primary to be synchronous with the orbital motion, (a) the primary is not at present filling its Roche lobe, and (b) the invisible secondary is the more massive component. (auth)

53901 OBSERVATIONS OF RAPID BLUE VARIABLES. 8. THE COMPANION TO MIRA. Warner, Brian (Univ. of Texas, Austin). Mon. Notic. Roy. Astron. Soc.; 159: No. 1, 95-100 (1972).

Ultraviolet photoelectric photometry with 2 s time resolution of Mira near minimum is reported. The light variations observed are attributed to o Cet B. It is shown that there are slow (~15 min) variations, superimposed on which are rare, short-lived flares. The luminosity of o Cet B is attributed to accretion heating, arising from mass loss from o Cet A, the slow variations being caused by inhomogeneities in the infalling material. The flares are probably intrinsic to o Cet B. (auth)

53902 OBSERVATIONS OF RAPID BLUE VARIABLES. 9. AM CVn (HZ29). Warner, Brian; Robinson, Edward L. (Univ. of Texas, Austin). Mon. Notic. Roy. Astron. Soc.; 159: No. 1, 101-11(1972).

Photometric observations with 1- and 3-s time resolution demonstrate the existence of rapid flickering in AM CVn. Mean light curves confirm the existence of a double-humped light curve with a period near 18 min. Using current data, and previously published observations by Ostriker and Hesser (Astrophys. J. (Letters), 153, L151, 1968) and Krzeminski (Acta Astr., 21, 133, 1971) a mean period of 1051.0505 s is derived, but it is shown that there is some phase jitter about this period. Periodogram analyses show the existence of long-lived coherent periodicities in the range 115 to 120 s. A binary star model is suggested for AM CVn, with an orbital period of 18 min. It is proposed that AM CVn represents a late stage of evolution of a cataclysmic variable star, in which all hydrogen has been removed from the system. (auth)

53903 STELLAR EVOLUTION TOWARD THE MAIN SEQUENCE. Bodenheimer, P. (Univ. of California, Santa Cruz). Rep. Progr. Phys.; 35: No. 1, 1-54(1972).

A review is presented of the evolution of stars during the period that starts just after formation in interstellar clouds and ends at the point of stabilization on the main sequence where nuclear reactions begin to provide the entire energy supply. During this pre-main-sequence phase the star shines at the expense of its gravitational potential energy. At the earlier stages this energy is released rapidly as the star experiences hydrodynamic collapse; later on the star contracts slowly through a series of states of quasihydrostatic equilibrium. The initial-boundary-value problem that must be solved to obtain the structure of a star as a function of time is discussed. The equations have been solved numerically for a wide range of stellar masses. The character of these solutions is described, with particular attention given to the effect upon the results of the assumed initial conditions. The theoretical results are subject to a number of observational tests. The observations which are discussed include (i) the properties of T Tauri stars, (ii) the color-magnitude diagrams of young clusters, (iii) the abundances of the rare light nuclei, particularly lithium, and (iv) the properties of the "infrared" stars. The observations of a number of objects which have been identified as protostars are reviewed. Inclusion of the effects of rotation in calculations of pre-main-sequence evolution presents a difficult numerical problem, and relevant observational material is very scarce. Some recent progress has been made; in particular, numerical work has strengthened the hypothesis that close binary systems are formed by fission of a rapidly rotating single star. Rotation must be of dominant importance during the earliest phases of evolution just after star formation. Future work on this problem is essential to an understanding of the formation of the solar system. (auth)

53904 R CORONAE BOREALIS VARIABLES IN THE LARGE MAGELLANIC CLOUD. Feast, M. W. (Radcliffe Observatory, Pretoria). Mon. Notic. Roy. Astron. Soc.; 158: No. 3, 11P-13P(1972).

Spectra were obtained of three RCB stars in the LMC. W Men ($M_v = -5.1$) and HV 12842 ($M_v \sim -4$) have weak C_2 absorption bands (maximum depression of the continuum ~11% in the 4737 Å sequence). This C_2 strength is similar to that in the galactic F type RCB stars, R CrB and RY Sgr. HV 5637 ($M_v = -4.0$) has very strong C_2 bands (maximum continuum depression ~72% in 4737 Å sequence). Such strong C_2 bands are characteristic of R type RCB stars like S Aps. Evidently both F and R type RCB stars are high luminosity objects. (auth)

53905 SPECTROSCOPIC AND PHOTOMETRIC STUDY OF THE PULSATING R CORONAE BOREALIS TYPE VARIABLE, RY SAGITTARII. Alexander, J. B.; Andrews, P. J.; Catchpole, R. M.; (and others) (Royal Observatory, Cape Town). Mon. Notic. Roy. Astron. Soc.; 158: No. 3, 305-60(1972).

Results are given of an intensive study of RY Sgr during the period 1967 to 1970. The rapid decline in brightness at the beginning of this period and the gradual rise to maximum light are covered. 382 emission lines (mostly identified) were found during the initial decline as was a continuum attributed to the electron attachment spectrum of CN. The development with time of this emission line chromospheric spectrum indicates both a lowering of the excitation and decrease in the effects of self-absorption. The chromosphere decays on a time scale of ~22 days. The initial decrease in photospheric radiation has a time scale of ~5 days or less. The absence of [Fe II] emission suggests that the density in the emitting region is greater than $\sim 10^{14}$ atoms cm^{-3} in the early stages of the decline if collisional excitation is dominant. During the decline displaced shell lines of Ca II (-200 km s^{-1}) were present. On the rise to light maximum and at maximum, the light and color curves show smooth variations ($V = 0.5$m, $(B-V) = 0.3$m, $(U-B) = 0.5$m) with a period of 38.6 days. A similar periodicity is present in the radial velocities (amplitude ~30 km s^{-1}) and it is concluded that RY Sgr is a pulsating variable (as originally suggested by Jacchia) as well as an RCB star. At some epochs on the rising branch the spectrum is normal (i.e., as at maximum) but the star is faint and red. This together with the infrared observations of Lee and Feast strongly supports the hypothesis of extinction by a circumstellar dust shell. Values of $Av/E_{B-V} = 4.3$ and $E_{U-B}/E_{B-V} = 1.3$ are found for the shell. Abnormal spectra and colors follow a drop in light on the rising branch. They are apparently due to the filling in of the photospheric absorption lines by chromospheric emission. The primary cause of this phase seems to be a decrease in photospheric light, possibly due to the formation of a fresh dust shell near the photosphere. Displaced shell absorption lines (Ca II and Na I) are present at this stage. The pulsations of RY Sgr are broadly consistent with recent work by Trimble on the pulsation of helium stars. (auth)

53906 BLACK HOLES AND THE SECOND LAW. Bekenstein, J. D. (Joseph Henry Labs., Princeton, N. J.). Lett. Nuovo Cim.; 4: No. 15, 737-40(12 Aug 1972).

Black-hole physics seems to provide at least two ways in which the second law of thermodynamics may be transcended or violated. The second law is formulated in a form suitable for black-hole physics which resolved the transcendence problem. It is also indicated why Geroch's gedanken experiment does not, in fact, violate the second law. (W.D.M.)

53907 DETECTION OF NEUTRON STARS. Apparao, K. M. V. (Tata Inst. of Fundamental Research, Bombay). Lett. Nuovo Cim.; 4: No. 15, 809-10(12 Aug 1972).

Neutron stars when formed have surface temperatures in excess of 10^7°K, but generally cool down to about 10^6°K in about a million years. These stars are expected to emit x radiation and it is suggested that the x rays from the neutron stars in the nearest pulsars CP 0950, CP 1133, PSR 1929, and CP 0808 can be detected. The flux from CP 0950 may have already been detected, if it can be identified with the x-ray source Leo XR-1. (W.D.M.)

53908 INTERNAL STRUCTURE OF NEUTRON STARS. Arponen, Jouko (Univ. of Helsinki). Nucl. Phys.; A191: No. 2, 257-82(1972).

The equation of state and the structure and composition of neutron star matter are investigated in the density region 3.1×10^{11} to 2×10^{15} g/cm³. Below the density 3.1×10^{11} g/cm³ the matter is a solid consisting of neutron-rich nuclei in a degenerate electron gas. At 3.1×10^{11} g/cm³ neutrons start to drip out of the nuclei; as the density increases, the lattice spacing continuously decreases while the geometrical size of the nuclei only slightly increases, until at about 15×10^{13} g/cm³ the nuclei disappear by coalescing into a homogeneous liquid in an almost continuous phase transition. The maximum proton number per nucleus is 40, which is obtained between the densities 1 to 2.5×10^{13} g/cm³; after that the proton number decreases until at the solid-to-liquid phase boundary it is about 20. In the liquid-core region, muons appear at the density 20.5×10^{13} g/cm³. The calculations use the differential Thomas–Fermi theory in connection with a new model for the nuclear matter energy. The model is based on the parametrization of the Brueckner G-matrix in conjunction with a few empirical requirements concerning the saturation of the symmetric nuclear matter. It is shown that very small modifications in the details of the nuclear matter energy may lead to considerable differences in the resulting neutron star structure; for example the density of matter at the solid-to-liquid phase boundary is found to be very sensitive to such details. One of the main reasons for this is that

the stability of the liquid against clustering into separate nuclei depends mainly on the second derivatives of the nuclear matter energy with respect to neutron and proton densities; for these second derivatives there exist no very reliable theoretical or phenomenological predictions so far. To check that the Thomas–Fermi theory together with the model for the nuclear matter energy works satisfactorily, a test calculation is made about finite nuclei of difference sizes between A = 16 and 400. (auth)

Quasi-Stellar, Radio, and X-Ray Sources

Refer also to abstracts 53818, 53857, and 54144.

53909 PARAMETRIC DOWN-CONVERSION IN ASTROPHYSICAL MASERS. Goldreich, Peter; Kwan, John Y. (California Inst. of Tech., Pasadena). Astrophys. J.; 176: No. 2, 345-51 (1 Sep 1972).

The mechanism of parametric down-conversion proposed by Litvak cannot explain the observed preference for circular polarization in OH maser emission because the nonlinear interaction between oppositely circularly polarized microwaves is too weak. (auth)

53910 FINE STRUCTURE IN H II REGIONS: SYNTHESIS OBSERVATIONS AT 11 AND 3.7 CENTIMETERS. Balick, Bruce (Cornell Univ., Ithaca, N. Y.). Astrophys. J.; 176: No. 2, 353-65(1 Sep 1972).

Interferometric synthesis observations of the H II regions DR 21, W51 components G49.5−0.4 and G49.3−0.3, W33, NGC2264 (southern component), NGC 2175, and IC 410 are reported. The sources were observed at frequencies of 2695 and 8085 MHz; the resulting synthesized beam diameters were ~10′′ and 3′′, respectively. Fine structure with scale sizes of $10^{-1.5}$ pc were observed in some sources, whereas intermediate (~$10^{-0.5}$ pc) or no structure was observed in others. Typical emission measures of $10^{7.5}$ pc cm^{-6} and electron temperatures of 10^4 °K were found for the fine structure. Thus densities of $10^{4.5}$ cm^{-3} and masses of $10^{-1.5}$ $M_\odot$ are implied. The relationship between the structure and the parent H II region is discussed. (auth)

53911 INTERPRETATION OF ROTATION MEASURES OF RADIO SOURCES. II. Mitton, Simon; Reinhardt, Michael (Inst. of Theoretical Astronomy, Cambridge, Eng.). Astron. Astrophys.; 20: No. 3, 337-40(Sep 1972).

The systematic behavior of the rotation measures of radio galaxies, quasars, and unidentified sources is discussed. The contribution of a galactic magnetic field directed along the local spiral arm and the dependence on galactic latitude are investigated for different classes of object. Radio galaxies have significantly larger rotation measures than quasars. This is to be expected, as the intrinsic source contributions are a function of redshift because of the wavelength dependent definition of the rotation measure. A redshift dependence of the rotation measures of quasars, after subtraction of the regular galactic contribution, is indicated. The data are compatible with the assumption that the intrinsic rotation measures of quasars on the average do not differ from those of radio galaxies, and that they are independent of redshift. At present the rotation measures of the unidentified sources do not give any strong clues as to their nature. (auth)

53912 STUDY OF GALACTIC SUPERNOVA REMNANTS. II. SUPERNOVA RATE, GALACTIC RADIO EMISSION AND PULSARS. Ilovaisky, Sergio A.; Lequeux, James (CEN, Saclay, France). Astron. Astrophys.; 20: No. 3, 347-56(Sep 1972).

Using the radio luminosity function at 1 GHz for galactic supernova remnants (SNR) derived in a previous article (Paper I) together with independent age estimates for six SNR, a mean interval between supernova outbursts in the Galaxy of 50 yr was obtained. The total number of discrete remnants in the Galaxy is presented as a function of the linear diameter, D. Upper and lower limits are given by two possible cases, Case A; adiabatic expansion for D > 4 pc, and Case B: adiabatic expansion for 4 < D < 30 pc followed by isothermal expansion for D > 30 pc. Lower and upper limits corresponding to Cases A and B respectively for the maximum diameter, D_M, and age, t_M, that a discrete remnant may have, and the total number of objects in the Galaxy, N(<D_M) are given. It was found that 110 < D_M < 380 pc, $1.0 \times 10^6 < t_M < 6.0 \times 10^6$, and $2.0 \times 10^4 <$ N(<D_M) < 1.2×10^5 SNR. The surface density of supernova remnants is compared to that of radio pulsars, using objects in the same age range and allowing for the two selection effects found to be present in the pulsar sample (age-limiting and flux-limiting effects). It was found that the surface density of pulsars, within a factor of two, is equal to that of SNR. This, plus the fact that the z-distributions of the two types of objects are quite similar, shows that it is possible that most supernova explosions have given birth to pulsars. A new model is presented for the nonthermal galactic radio emission, based on the 150 MHz sky map of Landecker and Wielebinski (1970). This model features a two-disk structure with a radial extent of 8 to 10 kpc. The disks have full thicknesses of 500 and 2000 pc. The outer disk contributes 65% of the total emission and has an emissivity of 100 K kpc^{-1} at 150 MHz, about half that of the inner disk. The total integrated radio power at 1 GHz due to discrete, old SNR is compared to the output of the two-disk structure, for Cases A and B as well as a complementary case, where the radio emission ceases not at D_M but rather at 50 pc. In none of these cases does the total effective SNR output account for more than one-tenth of the total nonthermal galactic luminosity. However, it is possible that old SNR account for part of the non-thermal emissivity close to the galactic plane. (auth)

53913 OPTICAL POSITIONS OF RADIOSOURCES. Veron, M. P. (Observatoire Haute Provence, France). Astron. Astrophys.; 20: No. 3, 471-3(Sep 1972).

Optical positions of quasars and radiogalaxies were measured with an accuracy better than one arc second. The method of Schlesinger (1926) and usually for reference, stars from the AGK3 catalog, were used for this. (auth)

53914 STUDY OF THE LUNAR OCCULTATIONS OF ELEVEN RADIO SOURCES. Lyne, A. G. (Univ. of Manchester, Eng.). Mon. Notic. Roy. Astron. Soc.; 158: No. 4, 431-62(1972).

Observations of the lunar occultations of 11 radio sources were made at Jodrell Bank, using an interferometer to surmount some technical difficulties. Accurate positions and brightness distributions for these sources are given. Some of the observations were made at several frequencies, allowing a study of the variations of spectral index within the sources. In particular, 3C2, 3C245, and 3C279 are quasars which bear a striking resemblance to 3C273. For 3C2, the data suggest an identification of the radio jet with an optical one. (auth)

53915 INTERSTELLAR SCINTILLATION PATTERN OF PSR + 54. Galt, J. A.; Lyne, A. G. (Dominion Radio Astrophysical Observatory, Penticton, B. C.). Mon. Notic. Roy. Astron. Soc.; 158: No. 3, 281-90(1972).

The pulsar PSR 0329 + 54 was observed at 408 MHz simultaneously for an entire day at Jodrell Bank and Penticton. The separation of these stations is sufficient to permit detection of motions of the diffraction pattern produced by irregularities in the interstellar medium. The observations suggest that the scintillation pattern is stable. If this is the case, the results indicate a decorrelation length of 77,000 km and a velocity of 360 km s^{-1} at position angle 295° referred to the local standard of rest. This velocity is high compared to most motions in the Galaxy but it is consistent with velocity estimates made on the basis of single telescope observations. The motion can be attributed to either the interstellar plasma or the pulsar itself. Although this experiment does not distinguish between these two possibilities, it may indicate the existence of high pulsar velocities required by certain theories of pulsar formation. (auth)

53916 FASTER-THAN-LIGHT SYNCHROTRON RADIATION IN A VACUUM. Eidman, V. Ya. (Scientific-Research Radiophysics Inst., Gorky, USSR). Izv. Vysch. Ucheb. Zaved., Radiofiz.; 15: No. 4, 634-5(1972). (In Russian).

After the discovery of pulsars attention was turned to the possibilities of the radiation source moving at a velocity close to that of light, with the attendant difficulty of large amounts of matter with this characteristic. The author examines here still another possibility—that of producing radiation equivalent to the faster-than light radiation in a vacuum, a situation free of such a difficulty. (K.S.W.)

53917 TIME VARIATION OF X-RAY SPECTRUM AND OPTICAL LUMINOSITY OF SCO X-1. Rao, U. R. (Physical Research Lab., Ahmedabad, India); Chitnis, E. V.; Jayanthi, U. B.; (and others). pp 2-6 of 12th International Conference on Cosmic Rays, Hobart, Australia. Vol. 1. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From twelfth international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.1).

Simultaneous, optical and x-ray observations from Sco X-1, conducted with rocket-borne instrumentation both from the Thumba Equatorial Rocket Launching Station, India, and the Kagoshima Space Centre, Japan, during the period April–August 1969 are

presented and compared with similar results obtained from Lawrence Radiation Laboratory Group. X-ray observations reported were performed over the spectral range 2 to 20 keV. The interrelationships of various parameters such as temperature, density, and size which characterize the properties of the isothermal cloud postulated for Sco X-1 x-ray source and the correlation of these physical parameters with the optical luminosity were investigated. The results conclusively show that the Scorpio x-ray source is completely characterized by its temperature. As the temperature increases, its source size decreases with a corresponding increase in the density and a decrease in the optical luminosity. The order of magnitude calculations indicates that Sco X-1 is characterized by a temperature of about 10^7 to 10^{8}°K, a density of about 10^{16} to 10^{17} cm^{-3} and radius of about 10^8 to 10^9 cm respectively and is consistent with the source being a white dwarf. (auth) (Australia)

53918 X-RAY AND OPTICAL OBSERVATIONS OF SCO X-1 AND OBSERVATIONS OF THE X-RAY BACKGROUND. Garmire, G. P. (California Inst. of Tech., Pasadena); Moore, W.; Stevens, J. C.; Kristian, J.; Lanning, H. pp 7-12 of 12th International Conference on Cosmic Rays, Hobart, Australia. Vol. 1. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.1).

Optical and x-ray observations using a novel x-ray detector configuration were made of Sco X-1 on June 27, 1970 and August 28, 1970. Two spectra were obtained on the 200-inch Hale Telescope during and following the June 27 flight. The results show only a change in x-ray temperature from $T_6 = 63^{+3}_{-3}$ to $T_6 = 58 \pm 3$ for an optical change from $m_B = 12.35$ to $m_B = 13.0$, respectively. No line at 6 keV was observed in the x-ray background to a one standard derivation level of 0.03 ph/(cm^2 sec sr) contrary to several current observations. (auth) (Australia)

53919 SPECTRAL AND PULSED X-RAY EMISSION FROM THE CRAB NEBULA. Tuohy, I. R. (Univ. of Adelaide); Harries, J. R.; Luyendyk, A. P. J.; Broderick, A. J.; Fenton, K. B. pp 13-18 of 12th International Conference on Cosmic Rays, Hobart, Australia. Vol. 1. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From twelfth international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.1).

The Crab Nebula was observed during an unstabilized Skylark rocket flight from Woomera, South Australia on July 10, 1970. The instrumentation included two wall-less proportional counters which were calibrated continuously throughout the flight. The Crab Nebula x-ray spectrum between 2.3 and 9.9 keV was found to be: $(dN/dE) = (0.50 \pm 0.04)\ (E/5)^{-2.04 \pm .09}$ photons/cm^2-sec-keV. Pulsed emission from NP 0532 was also detected. In addition to the two main peaks, the possibility of a third peak is discussed. (auth) (Australia)

53920 INTENSITY AND ENERGY SPECTRA OF SEVERAL X-RAY SOURCES IN THE 20- TO 150-keV ENERGY BAND. Agarwal, P. C.; Biswas, S.; Gokhale, G. S.; (and others) (Tata Inst. of Fundamental Research, Bombay). pp 20-5 of 12th International Conference on Cosmic Rays, Hobart, Australia. Vol. 1. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.1).

Using oriented x-ray telescopes the region of the sky R.A. 13 hrs to 22 hrs and $\delta - 20°$ to +50° was scanned in five balloon flights carried out from Hyderabad since April 1968. The combined data reveals the presence of two high galactic latitude regions of hard x-ray emission, one in Virgo and the other close to the Coma cluster. The spectral characteristics of all the sources seen in the 20 to 150 keV range are presented. (auth) (Australia)

53921 SHORT PERIOD VARIATIONS IN THE INTENSITY AND ENERGY SPECTRUM OF CYG X-1. Agarwal, P. C.; Gokhale, G. S.; Iyengar, V. S.; (and others) (Tata Inst. of Fundamental Research, Bombay). pp 26-9 of 12th International Conference on Cosmic Rays, Hobart, Australia. Vol. 1. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From twelfth international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.1).

A balloon flight was carried out from Hyderabad on April 5, 1971 using an oriented x-ray telescope to study short-period variations and possible pulsations in the x-ray intensity of Cyg X-1. The telescope was programmed to point alternately due north and 45° east of north. The total effective time of exposure on Cyg X-1 was about 3 hours. During this period the results show that the intensity of x-rays in the energy range 20 to 150 keV varies rapidly over periods of a few minutes by a factor of 2 to 3. The spectral analysis of the data shows that besides the intensity the spectrum also varies. The data was subjected to a fast folding analysis to examine whether any periodic components were present at high energies in the x-ray emission from Cyg X-1. There was no indication of a pulsating component with an intensity higher than 10% of the total emission. (auth) (Australia)

53922 SEARCH FOR PULSED GAMMA RAYS FROM THE CRAB. Kinzer, R. L.; Seeman, N.; Share, G. H. (Naval Research Lab., Washington, D. C.). pp 45-50 of 12th International Conference on Cosmic Rays, Hobart, Australia. Vol. 1. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From twelfth international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.1).

A telescope incorporating a stack of nuclear emulsions as a converter, a wide-gap spark chamber, and other particle detectors was flown in a search for gamma radiation from the Crab Pulsar. Preliminary results obtained from spark chamber photographs have given some evidence for emission of pulsed photons >10 MeV. An attempt to confirm this observation by locating the γ-ray interactions in the emulsion was made. This analysis reduces the angular uncertainty to $\leq 2\frac{1}{2}°$ but also raises the telescope's effective energy threshold. Of 29 γ-ray events located to date which were coincident in time with optical pulsations, only 1 originated $<2\frac{1}{2}°$ from the Crab. This is consistent with the number expected from background and places an upper limit of 1×10^{-4} γ/cm^2-sec to the pulsed flux above 20 MeV. The lack of confirmation suggests that the earlier result was due primarily to photons below the 20 MeV effective threshold set by the emulsion analysis, or was a statistical fluctuation. (auth) (Australia)

53923 INVESTIGATION OF GAMMA RADIATION FROM THE CRAB PULSAR. Kettenring, G.; Mayer-Hasselwander, H. A.; Pfeffermann, E.; (and others) (Max-Planck-Institut fuer Physik und Astrophysik, Munich). pp 57-62 of 12th International Conference on Cosmic Rays, Hobart, Australia. Vol. 1. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From twelfth international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.1).

The Crab pulsar was investigated with a gamma-ray astronomy spark chamber balloon experiment. The results of one of several successful flights indicate an upper limit of the pulsed gamma-ray spectrum above ~20 MeV that is lower than values reported previously, but still lies a factor of three above the extrapolation from lower energies into the region above 20 MeV. (auth) (Australia)

53924 NEW POINT GAMMA RAY SOURCE LIBRA γ-1: EVIDENCE FOR TIME VARIATION. Frye, G. M. Jr. (Case Western Reserve Univ., Cleveland); Albats, P. A.; Zych, A. D.; (and others). pp 70-5 of 12th International Conference on Cosmic Rays, Hobart, Australia. Vol. 1. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From twelfth international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.1).

The first possible discrete source of gamma radiation, Sgr γ-1, was reported in 1969 by combining the results of two balloon flights made two weeks apart at latitude 33°S in south eastern Australia. An additional two sources Gγ 2 + 3 and Gγ 341 + 1 were reported by the same teams in 1971 following the combined analyses of these two flights plus a third flight at latitude 23°S made 9 months later in north eastern Australia. Only the region having greater than 50% of the maximum effective exposure for the combined three flights was considered in this analysis and all three sources showed some excess radiation during each flight. An analysis was made of the third flight over a region of sky having an exposure exceeding 50% of the maximum exposure and this indicated the presence of another possible discrete source named tentatively Libra γ-1. The region was also covered by the second flight but no excess gamma radiation from the same region was evident on that flight. (Australia)

53925 RADIATION MECHANISM FOR PULSARS. Lerche, I. (Univ. of Chicago). pp 354-8 of 12th International Conference on Cosmic Rays, Hobart, Australia. Vol. 1. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From twelfth international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.1).

An oscillating interface between a rotating, radiating magnetic dipole and an external plasma is the source of pulsar radiation produced over a broad band of high frequencies (10^8 to 10^{18} cHz/s). The efficiency of the mechanism is so high that the oscillation energy goes mainly into radiation in each cycle of the oscillation. The mechanism automatically accounts for (i) pulse structure, (ii) polarization, (iii) power spectral dependence of pulsar radia-

tion. A recent application of the basic mechanism to extragalactic radio sources by Rees (1970) indicates that it is of wider astrophysical import than just as a mechanism to account for the observed properties of pulsars. (auth) (Australia)

53926 TRANSFER EFFECTS ON LINES AND CONTINUUM IN OPTICALLY THICK X-RAY SOURCES. Felten, J. E. (Univ. of Arizona, Tucson); Rees, M. J. pp 415-18 of 12th International Conference on Cosmic Rays, Hobart, Australia. Vol. 1. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From twelfth international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.1).

The thermal spectrum emergent from a hot plasma cloud may be altered substantially by transfer effects if the cloud is not optically thin. If an isothermal cloud in Sco X-1 has electron-scattering optical thickness $\tau_{es} \gg 1$, the radiation density is sufficient to alter the ionization equilibrium. Compton-scattered wings of prominent x-ray lines will be suppressed by a factor ~ 10 for $\tau_{es} \gtrsim 10$. Line cores arise in the surface layer and will be less affected. Resonance scattering as well as Compton scattering affects the line profiles. The emergent free-free continuum is also changed by Compton scatterings. Rayleigh-Jeans at low ν shows a characteristic transition region with $I(\nu) \propto \nu$ if $\tau_{es} \gtrsim 10$ and the cloud is homogeneous. For Sco X-1 this may lie near 1.5 μ. It might appear at other frequencies in other objects with large τ_{es}. The x-ray continuum in $h\nu > kT$ will approach an equilibrium (Bose-Einstein) shape $\nu^3 \exp(-h\nu/kT)$ if $\tau_{es} \gtrsim (m_e c^2/3kT)^{\frac{1}{2}}$. This affects temperature estimates. For larger τ_{es} this thermalization may extend down to the optical band. (auth) (Australia)

Solar Phenomena

Refer also to abstracts 54048, 54390, 54508, 54955, and 54956.

53927 (NASA-TM-X-2440, pp 193-208) SOLAR-FLARE PARTICLE RADIATION. Lanzerotti, L. J. (Bell Telephone Labs., Inc., Murray Hill, N. J.). Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

The characteristics of the solar particles accelerated by solar flares and subsequently observed near the orbit of the earth are studied. Considered are solar particle intensity-time profiles, the composition and spectra of solar flare events, and the propagation of solar particles in interplanetary space. The effects of solar particles at the earth, riometer observations of polar cap cosmic noise absorption events, and the production of solar cell damage at synchronous altitudes by solar protons are also discussed. 94 references, 19 figures. (auth) (STAR)

53928 (NASA-TM-X-2440, pp 329-35) SIGNIFICANT SOLAR-PROTON EVENTS IN THE 20TH SOLAR CYCLE FOR THE PERIOD OCTOBER 1964 TO MARCH 1970. Atwell, W. (Lockheed Electronics Co., Houston, Tex.). Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

Solar-proton data are presented from observations by the IMP 2, 3, F and G satellites. The NASA Solar Particle Alert Network (SPAN) solar optical- and radio-frequency data for the period May 1967 to March 1970 are associated with the proton events observed by the IMP F and G satellites; however, missing data are supplemented with data recorded at other international observatories. From a radiation-hazard standpoint, NASA is concerned with solar-proton events of the order of 10^9 proton/cm^2. Radiation dose data are presented for some of the large proton events that have occurred thus far in the 20th solar cycle and are compared with some of the large proton events of the 19th solar cycle. Finally, the results of a simple parametric correlation study are presented for both the 19th and 20th solar cycles. 7 tables. (auth)

53929 (NASA-TM-X-2440, pp 336-44) TIME BEHAVIOR OF SOLAR-FLARE PARTICLES TO 5 AU. Haffner, J. W. (North American Rockwell Corp., Downey, Calif.). Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

A simple model of solar flare radiation event particle transport is developed to permit the calculation of fluxes and related quantities as a function of distance from the sun (R). This model assumes the particles spiral around the solar magnetic field lines with a constant pitch angle. The particle angular distributions and onset plus arrival times as functions of energy at 1 AU agree with observations if the pitch angle distribution peaks near 90°. As a consequence, the time-dependence factor is essentially proportional to $R^{-1.7}$, (R in AU), and the event flux is proportional to R^{-2}. (auth)

53930 (NASA-TM-X-2440, pp 345-55) SOLAR COSMIC-RAY HAZARD TO INTERPLANETARY AND EARTH-ORBITAL SPACE TRAVEL. Yucker, W. R. (McDonnell Douglas Astronautics Co., Huntington Beach, Calif.). Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

A statistical treatment is given of the radiation hazard to astronauts due to solar cosmic-ray protons. While several similar studies have been conducted in the past, objections to the use of this approach to determining shielding requirements have been raised due to the limited number of solar proton events for which data are available. More recent data are incorporated into the present analysis, including events from 1956 to 1969, in order to improve the accuracy of the predicted mission fluence and dose. The effects of the finite data sample are discussed. Also, an attempt is made to present a unified and consistent view of the solar cosmic ray proton hazard and to justify the application of a statistical approach for mission planning. Mission fluence and dose versus shield thickness data are presented for mission lengths up to 3 years during periods of maximum and minimum solar activity; these correspond to various levels of confidence that the predicted hazard will not be exceeded. 16 figures, 23 references. (auth)

53931 (NASA-TM-X-2440, pp 356-61) SHORT-TERM PREDICTION OF E ≥ 10-MeV PROTON FLUXES FROM SOLAR FLARES. Kuck, George A. (Air Force Weapons Lab., Kirtland AFB, N. Mex.). Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

One problem is the prediction of ionospheric effects related to energetic proton emissions from the sun. The intensity and duration of these charged particle emissions are related to the optical, radio, and x-ray emissions from the solar flares. Radio and x-ray data give an important indication of proton production. Cm radio bursts with a high flux density and a slope reflecting greater flux values at higher frequencies are often proton productive. Examination of the data summaries has shown that the meter classification of flares as type II or type IV, even though qualitative, should be used in conjunction with the cm radio criteria. The peak intensity of the proton flux E ≥ 10 MeV correlates better with the integrated 1 to 8 Å x-ray bursts than with the integrated cm radio bursts, peak cm radio flux, or peak x-ray flux. Free-free transition theory was used to relate the x-ray flux. Free-free transition theory was used to relate the x-ray intensities recorded by different satellites with the peak proton fluxes observed at the earth. Both the anisotropic and isotropic diffusion theories could be used to extrapolate proton fluxes for E ≥ 10 MeV for over 50% of the particle events. The isotropic diffusion theory uses a diffusion coefficient: $D = Mr^{\beta}$. It was found that M and β tended to be functions of flare position on the solar disk. A measurement of the interplanetary flux in near-earth space gives a good indication of the polar cap fluxes. It was found that the 30-MHz absorption over the poles during a PCA is proportional to the square root of the integral proton flux E ≥ 11 MeV in interplanetary space: $J = KA^2$, with $K = 8 \pm 2$ and J in protons/cm^2-sec-ster. (auth)

53932 SOLAR-FLARE-PARTICLE PROPAGATION: COMPARISON OF A NEW ANALYTIC SOLUTION WITH SPACECRAFT MEASUREMENTS. Lupton, John Edward. Pasadena, Calif.; California Inst. of Tech. (1972). 197p. University Microfilms Order No. 72-22,555.

Thesis.

A new analytic solution has been obtained to the complete Fokker-Planck equation for solar-flare particle propagation including the effects of convection, energy-change, corotation, and diffusion with κ_r = constant and $\kappa_\theta \propto r^2$. It is assumed that the particles are injected impulsively at a single point in space, and that a boundary exists beyond which the particles are free to escape. Several solar-flare particle events have been observed with the Caltech Solar and Galactic Cosmic Ray Experiment aboard OGO-6. Detailed comparisons of the predictions of the new solution with these observations of 1- to 70-MeV protons show that the model adequately describes both the rise and decay times, indicating that κ_r = constant is a better description of conditions inside 1 AU than is $\kappa_r \propto r$. With an outer boundary at 2.7 AU, a solar-wind velocity of 400 km/sec, and a radial diffusion coefficient $\kappa_r \approx 2\text{-}8 \times 10^{20}$ cm^2/sec, the model gives reasonable fits to the time-profile of 1- to 10-MeV protons from "classical" flare-associated events. It is not necessary to invoke a scatter-free region near the Sun in order to reproduce the fast rise times observed for directly-connected events. The new solution also yields a time-evoluation for the vector anisotropy which agrees well with previously reported observations. In addition, the new solution predicts that, during the decay phase, a typical convex spectral feature initially at energy T_0 will move to lower energies at an

exponential rate given by $T_{KINK} = T_0 \exp(-t/\tau_{KINK})$. Assuming adiabatic deceleration and a boundary at 2.7 AU, the solution yields $\tau_{KINK} \approx$ 100h, which is faster than the measured ~200h time constant and slower than the adiabatic rate of ~78h at 1 AU. Two possible explanations are that the boundary is at ~5 AU or that some other energy-change process is operative. (Diss. Abstr. Int., B)

53933 VIDEOMAGNETOGRAPH STUDY OF DIFFUSION OF SOLAR MAGNETIC FIELDS IN WEAK-PLAGE REGIONS. Smithson, Robert Carroll. Pasadena, Calif.; California Inst. of Tech. (1972). 223p. University Microfilms Order No. 72-22,615.

Thesis.

A new instrument for use in astronomical research has been developed. This is the differential video photometer, a device for detecting differences in light intensity between two television pictures. With a suitable source of video, the device is capable of detecting intensity differences of the order of one part in one thousand. It should be useful in many applications, such as colorimetry, polarimetry, motion detection, and doppler shift measurements. It has been used thus far primarily as a videomagnetograph which measures the line-of-sight component of the solar magnetic field in the photosphere. Sensitivity to magnetic field strength is on the order of 5 to 10 gauss. A study has been made of the characteristics of magnetic flux diffusion in weak plage regions. Points of enhanced magnetic field have been found to exist which have lifetimes of about 3 to 4 days, and which move in a random walk with a step time short compared to 24 hours. The random walk of these points considered as discrete entities is not, however, responsible for much of the flux diffusion in the weak plage regions. The R.M.S. displacement of the points is about 7800 km in 24 hours. A second form of flux transport has been found in which in a period of a few hours a previously stable point will become unstable, and either shoot out a tongue of flux, or begin to move as a unit. This process can move flux over distances of the order of 10,000 km at apparent velocities of 1 to 2 km/sec. This process may be responsible for most of the flux transport in weak plage regions. (Diss. Abstr. Int., B)

53934 STUDIES OF TYPE III BURSTS AND REFRACTION IN THE SOLAR CORONA AT HECTOMETER WAVELENGTHS. Howard, Edward Glenn. Washington, D. C.; Georgetown Univ. (1972). 181p. University Microfilms Order No. 72-22,772.

Thesis.

A ray tracing program was developed and applied to a coronal model in order to study the visibility of Type III radio bursts seen from the Earth. The model includes an enhanced conical shaped streamer in the solar corona in which emission takes place. It is possible to vary emission bandwidth, enhancement of the streamer over the ambient corona, opening angle of the streamer, and the lateral or off-axis width of the emission region. Using this model, one can construct curves of radiation intensity as seen at Earth as a function of the heliocentric longitude of the source. These curves are termed I(L) curves, for intensity as a function of longitude. Both refraction due to the radial gradient of the solar electron density and refraction due to the transverse gradient due to the streamer enhancement electron density are included in the radiation plots. The plots show an isotropically radiating point source at locations both on and off the streamer axis. By combining point sources to form a distributed source it is possible to produce a wide range of radiation intensity I(L) curves. (TSS) (Diss. Abstr. Int., B)

53935 POSITION MEASUREMENTS OF SOLAR CONTINUUM AND TYPE-III BURST SOURCES AT DECAMETER WAVELENGTHS. Fitzenreiter, Richard Julius. Washington, D. C.; Catholic Univ. of America (1972). 173p. University Microfilms Order No. 72-22,688.

Thesis.

The position of a source of continuum in the active solar corona is analyzed as a function of frequency and aspect angle in order to explain the emission mechanism of stationary continuum. A plasma radiation source in the corona is characterized by a variation of position with frequency corresponding to the plasma level distribution in the source region. The other possible source mechanism, gyro-synchrotron radiation, is characterized by a localized source, i.e., radiation at all frequencies originating from the same position in the corona. Positions of sources of stationary continuum and Type III bursts occurring simultaneously during an 11-day period of solar activity in July, 1970, are determined using data in the range 20 to 60 MHz from the Clark Lake sweep frequency two mile baseline grating interferometer. With Type III bursts as the reference, relative positions of continuum and Type III bursts show that the continuum originates from the critical plasma levels over a wide range of frequencies corresponding to the range of coronal levels extending from 1.7 to 2.3 solar radii from the center of the Sun. This is clear evidence that the observed stationary continuum source radiates by the plasma radiation mechanism. The emission cone of a plasma radiation source is very narrow, but yet the source is observed over a wide range of aspect angles, implying the existence of density gradients in the source region. Using ray tracing, a model is determined for the density enhancement and gradients which allow the radiation to escape and be observed at the measured positions as a function of aspect angle. The resulting model is consistent with other radio and optical observations of active region streamers. (Diss. Abstr. Int., B)

53936 NEW SOLAR FLUCTUATION. Dicke, R. H. (Princeton Univ., N. J.). Astrophys. J.; 176: No. 2, 479-86(1 Sep 1972).

The fluctuation in the solar-oblateness signal during 1966 has been found to be strongly autocorrelated with a 25.3-day lag. The autocovariance functions show that the disturbed regions of the Sun occur in the vicinity of ±45° latitude for which the synodic rotation period is ~29.5 days. The 25-day correlation peak is positive as expected, but there is no indication of the equally strong 13-day negative half-rotation peak that would also be expected. It is concluded that the 25-day correlation may be due to density fluctuations occurring near the top of the radiative zone. (auth)

53937 CURRENT LIMITATION IN SOLAR FLARES. Smith, Dean F.; Priest, E. R. (National Center for Atmospheric Research, Boulder, Colo.). Astrophys. J.; 176: No. 2, 487-95 (1 Sep 1972).

It is shown that the ion-sound current instability will be the relevant mechanism of current dissipation in most instances in the fully ionized part of the solar atmosphere (upper chromosphere and corona). Since this instability has the same initial threshold as the Alfvén–Carlqvist instability, but a considerably lower threshold once the instability has started toward saturation, the Alfvén–Carlqvist instability will not occur. The linear and nonlinear stages of the ion-sound current instability are examined and a turbulent resistivity is given for the saturated state which is in agreement with laboratory experiments. This turbulent resistivity is applied to the Alfvén–Carlqvist model of a cylindrical current filament, and it is shown that enough energy could not be dissipated sufficiently fast for a solar flare. This turbulent resistivity is also applied to the "hard" phase of Syrovatsky's dynamic dissipation model, and it is shown that Syrovatsky's electromagnetic instability for instantaneous current-sheet interruption cannot occur. The possibility that the ion-sound turbulence can systematically accelerate a select group of particles is investigated. It is concluded that heating rather than acceleration will result. It is suggested that a small electric field acting over large distances is a potentially much more efficient accelerating mechanism. (auth)

53938 F AND K COMPONENTS OF THE SOLAR CORONA. Calbert, Roosevelt; Beard, David B. (Univ. of Kansas, Lawrence). Astrophys. J.; 176: No. 2, 497-509(1 Sep 1972).

By taking advantage of the different spatial dependencies of electrons and dust in the solar system, a reliable method was developed of separating the K component from the F component in measurements of the total solar coronal light as a function of elongation angle. By assuming a sum of inverse power of distance terms for electron density and using the same observational data, dust and electron density separation was obtained in good agreement with others who have used polarization and spectroscopic methods for the separation. An exponential dependence on the inverse of the distance consonant with contemporary cornal theory was also assumed and a very good fit to previous determinations of electron density was obtained. The F component was found to be nearly absent in long-wavelength (2.2 μ) measurements of the solar corona—an indication that diffraction is absent and that the minimum dust size is 0.2 μ. The minute F component present has an albedo of about 0.3. It was indicated that the minimum approach to the Sun of the dust particles is 10 solar radii, in agreement with theoretical calculations. As a result, compelling evidence was found that the F component is very much less at small elongations than believed previously. (auth)

53939 PROPERTIES OF A CORONAL HOLE DERIVED FROM EXTREME-ULTRAVIOLET OBSERVATIONS. Munro, Richard H.; Withbroe, George L. (Harvard Coll. Observatory, Cambridge, Mass.). Astrophys. J.; 176: No. 2, 511-20(1 Sep 1972).

A coronal "hole" is characterized by significant deficiency in the intensity of coronal emission lines, yet there is little change in lines and continua formed below 800,000°K except for the He I and He II emission features. Comparison of the hole with the normal quiet Sun indicates that the electron pressure is reduced by a factor of 3, the coronal temperature is lower by 600,000°K, and the temperature gradient in the chromospheric–coronal transition layer is less steep by an order of magnitude. The apparent insen-

sitivity of the lines formed in the transition layer to the physical conditions of the hole implies that the conductive flux from the corona is proportional to the square of the electron pressure. (auth)

53940 RAYLEIGH–TAYLOR INSTABILITY IN A COMPOSITE MEDIUM. Bhatia, P. K. (Univ. of Jodhpur, India). Cosmic Electrodyn.; 3: No. 2, 124-8(Jul 1972).

The effects of collisions with neutral atoms were studied on the dynamic stability of a composite medium in the presence of a uniform vertical magnetic field. The case of one-dimensional density gradient in the fluid medium was studied. An explicit solution was obtained by making use of a variational principle which is shown to characterize the problem. It was found that the stability criterion is the same as in the absence of collisions. The collisions, however, have a stabilizing influence. (auth)

53941 NONLINEAR MAGNETOSONIC WAVES IN A PLASMA WITH A FINITE CONDUCTIVITY. Sakai, Jun-ichi (Nagoya Univ., Japan). Cosmic Electrodyn.; 3: No. 2, 260-70(Jul 1972).

Nonlinear magnetosonic waves in a turbulent plasma, characterized by an effective electrical conductivity σ_{eff} due to microinstabilities, are governed by the Burgers type equation, which has a shock-like stationary solution. It is shown that initial magnetic pulses of gaussian and solitary wave forms first decay due to dissipation, and subsequently form a shock front whose steepness is determined by the opposing effects of nonlinearity and dissipation. This process is thought to be important in connection with shock formation in space plasmas. (auth)

53942 SOLAR-WIND HEATING. Barnes, Aaron (Ames Research Center, Moffett Field, Calif.); Brandt, John C.; Hartle, R. E.; Wolff, Charles L. Cosmic Electrodyn.; 3: No. 2, 254-9 (Jul 1972).

A number of workers (Barnes et al., 1971; Cuperman and Harten 1971; Wolff, et al., 1971) have developed detailed models aimed at understanding energy transport in the solar wind. The differences in objectives, physical assumptions, and results among these models are analyzed. (W.D.M.)

53943 THEORETICAL TREATMENT OF LUNAR PARTICLE SHADOWS. McGuire , Robert E. (Univ. of California, Berkeley). Cosmic Electrodyn.; 3: No. 2, 208-39(Jul 1972).

The interaction of particles having nonzero gyroradii with a spherical absorber such as the Moon is theoretically treated. The Moon is assumed to have no effect on ambient magnetic or electric fields, and collective interactions of the particles are ignored. Properties of particle shadows are investigated in a uniform magnetic field and also in the presence of a uniform particle drift normal to this field (as might be produced by a uniform electric field transverse to the magnetic field). Shadow properties are calculated for particles in specified narrow energy and pitch angle intervals. Numerous results are derived for the specific case of a detector in a low lunar orbit as well as some results on the structure of particle shadows as a general function of spatial position. (auth)

53944 MEAN DEPTH OF LINE FORMATION IN A MAGNETIC FIELD. Staude, Juergen (Zentralinstitut fuer Solar-Terrestrische Physik, Potsdam, Ger.). Solar Phys.; 24: No. 2, 255-61 (Jun 1972).

Probability interpretation of radiative transfer is used to calculate the contribution of different layers of the solar atmosphere to the emergent intensity. Generally the mean depths of line formation increase with increasing intensity; this is valid also for arbitrarily polarized constituents of a line formed in a magnetic field. (auth)

53945 SOLAR SEEING AND THE SPATIAL PROPERTIES OF THE FIVE-MINUTE OSCILLATIONS. Thomas, John H. (Univ. of Rochester, N. Y.). Solar Phys.; 24: No. 2, 262-73 (Jun 1972).

A numerical simulation of observations of the spatial properties of the five-minute oscillations is carried out, assuming the oscillations are internal gravity waves excited by granular convection according to the theory of Thomas et al. (1971). The simulation includes the effects of seeing and finite aperture. The details of the simulation are chosen to model the observational method of Frazier (1968a, b). The results show that the peak in the observed power spectrum of the oscillations can occur at a wavelength considerably longer than the true wavelength of the oscillations. In particular, the peak in Frazier's observed power spectra at wavelength $\lambda \approx 5000$ km is consistent with the considerably shorter true wavelength $\lambda \approx 1500$ km predicted by the gravity wave theory. (auth)

53946 VELOCITY OSCILLATIONS IN THE SOLAR ATMOSPHERE. Bhattacharyya, J. C. (Indian Inst. of Astrophysics, Kodaikanal). Solar Phys.; 24: No. 2, 274-87(Jun 1972).

From a series of long duration continuous Doppler records of selected spectral lines, characteristics of solar velocity oscillations were studied. Statistical distribution of the durations of the bursts of oscillations was estimated. From the nature of distortion of the waveforms of the oscillation, the presence of disturbing impulses was speculated. Constancy and homogeneity of the oscillations were examined from detailed spectral density plots. Duration indices for the oscillations at different heights in the solar atmosphere were derived by estimating mean spectral densities of characteristic oscillation amplitudes during several individual bursts and comparing them with corresponding spectral densities from long records. The variation among experimental results is explained as due to the limitations of the power spectral analysis method on short records. (auth)

53947 MAGNETIC FIELDS AND HELIUM-D_3 SPECTROHELIOGRAMS. Chapman, G. A. (Aerospace Corp., El Segundo, Calif.). Solar Phys.; 24: No. 2, 288-300(Jun 1972).

Spectroheliograms, having a resolution approaching 2″, were obtained which show He$-D_3$ in absorption against the disk. The He$-D_3$ features were compared with the distribution of magnetic fields and with Hα structures. The brightest regions in Hα usually show the strongest D_3 absorption. Most Hα dark filaments show some D_3 absorption, but the degree of correlation varies from filament to filament. The correlation between $B_{||}$ and He$-D_3$ absorption is rather poor and the He features are much more diffuse than the photospheric magnetic field. (auth)

53948 CHARACTERISTICS OF THE Ca II K-LINE PROFILES IN THE QUIET SUN. Liu, Sou-yang; Smith, Elske v.P. (Univ. of Maryland, College Park). Solar Phys.; 24: No. 2, 301-9(Jun 1972).

Feature-to-feature identification is made on simultaneous Ca II K-line spectrograms (SG) and K_{2v} spectroheliograms (SHG). The line profiles in plages and in the network boundary nearly always have double-peaked reversal in the core, while those inside the cells present all possibilities: double-peaked, single-peaked on violet side, single-peaked on red side, and unreversed absorption. Statistics of the profiles in the quiet chromosphere show that 50% are K_{2V2} double-peaked, 20% are K_{2v} single-peaked, 10% are K_{2r} single-peaked, and 20% show only incipient reversal or even totally lack any reversal. Attention is directed to the nontrivial contribution of these absorption profiles which are formed in "dark regions" shown on SHG's. The physical conditions inferred from different kinds of profiles are briefly discussed. (auth)

53949 IONIZED HELIUM IN PROMINENCES AND IN THE CHROMOSPHERE. Hirayama, Tadashi (Sacramento Peak Observatory, Sunspot, N. Mex.). Solar Phys.; 24: No. 2, 310-23 (Jun 1972).

Quiescent Prominences: It is found that HE II 4686 is emitted in the same cold region of $\lesssim$10,000 K as hydrogen, metal, and neutral helium emission lines. This conclusion is based on the finding that the observed width of λ4686 is the same as the calculated width of λ4686. The calculated width is derived from the observed widths of hydrogen and metallic lines. The large intensity of He II 4686 in $\lesssim$10,000 K can be explained by the ionization of He II due to the uv radiation below 228 Å that comes from the corona and the transition region. Loop Prominences: The very broad width (30 to 50 km s^{-1}) of λ4686 for two post-flare loop prominences shows that the He II line is emitted in hot regions different from regions of hydrogen and metal emission. From the widths of the Balmer lines and many metallic lines the kinetic temperature for one loop is found to be 16,000 K in one part and 7600 K in another part. The electron densities are $10^{12.0}$ cm^{-3} and less than $10^{11.0}$ cm^{-3} respectively. Chromosphere: The intensity of λ4686 in the chromosphere can be interpreted in terms of a temperature of $\lesssim$10,000 K with the ionization due to uv radiation. But, since observations of the width of λ4686 are not available, a definitive conclusion for the chromosphere cannot be reached. (auth)

53950 METHOD TO CALCULATE ELECTRIC CURRENTS IN QUIESCENT PROMINENCES. Anzer, Ulrich (Max-Planck-Institut fuer Physik und Astrophysik, Munich). Solar Phys.; 24: No. 2, 324-35(Jun 1972).

A 2-dimensional model of the magnetic field associated with quiescent prominences is presented. The coronal field is assumed to be current-free, currents are only allowed in the photosphere and inside the prominence. The prominence is taken to be infinitely thin. For this model a method is given to calculate the field configuration from the observed normal component of the field both in the photosphere and the prominence. The normal

field components are inferred from disc observations and Hα limb observations. The sheet currents inside the prominence are calculated and the resulting Lorentz force is compared with the gravitational force. Within the range of uncertainty in the total hydrogen density of quiescent prominences it is possible to give models where the gravity is balanced by the Lorentz force. (auth)

53951 INTERPRETATION OF THE π-COMPONENT SPLITTING IN SUNSPOT SPECTRA. Obridko, V. N.; Demkina, L. B. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-wave Propagation, Moscow). Solar Phys.; 24: No. 2, 336-41 (Jun 1972).

It is shown that in order to explain the observed splitting of the π-component in the sunspot umbra spectrum by the hypothesis of the coexistence in sunspots of weak- and strong-field regions with opposite polarities, one has to admit the additional assumption that in the weak-field regions the Doppler halfwidth ($\Delta\lambda_D$) and the ratio between line opacity and continuum opacity (η_0) are both less than those in the strong-field regions. (auth)

53952 C_2 LINES IN SUNSPOT SPECTRA. Woehl, Hubertus (Univ., Sternwarte, Goettingen, Ger.). Solar Phys.; 24: No. 2, 342-53(Jun 1972).

The questionable existence of C_2 absorption lines in spectra of sunspots was checked. In two umbral spectra of large single sunspots evidence for the presence of lines of the (0,0) band and of the (0,1) band was found. (auth)

53953 C_2 IN SUNSPOTS. Harvey, J. W. (Kitt Peak National Observatory, Tucson, Ariz.). Solar Phys.; 24: No. 2, 354-5(Jun 1972).

The existence of C_2 lines in the spectrum of sunspot umbras has been questioned by Branch (1969) and Schadee (1970), while Wöhl (1971, 1972) found positive evidence for their presence. Since molecular equilibrium calculations (e.g., Tsuji, 1964) show that C_2 should be extremely weak in sunspot umbras, a resolution of these conflicting results is important. Results are presented which show that C_2 lines are strengthened in the penumbra relative to the photosphere and are much weaker in the umbra in agreement with the predictions of molecular equilibrium calculations. (W.D.M.)

53954 Z DEPENDENCE OF THE LEVEL INTERVALS IN $2s^22p^2$, $2s^22p^3$, AND $2s^22p^4$. Edlen, Bengt (Univ. of Lund, Sweden). Solar Phys.; 24: No. 2, 356-67(Jun 1972).

Values of the level intervals in the ground configurations $2s^2\,2p^2$, $2s^2\,2p^3$, and $2s^2\,2p^4$ have been critically compiled from laboratory observations and from observations of nebular and coronal forbidden transitions. The data are represented within experimental errors by means of semi-empirical extrapolation formulae which contain from 3 to 5 adjusted parameters. The results provide means for checking laboratory and astrophysical identifications and measurements. Tables of "best" level values are given for the configurations concerned. (auth)

53955 ATLAS OF MAGNETIC FIELDS IN THE SOLAR CORONA. Newkirk, Gordon Jr. (High Altitude Observatory, Boulder, Colo.); Trotter, Dorothy E.; Altschuler, Martin D.; Howard, Robert. Solar Phys.; 24: No. 2, 370-2(Jun 1972).

An atlas is described which provides maps of the coronal (current-free) magnetic field from August 1959 to June 1970. The Atlas contains some 11,000 maps depicting magnetic field lines from 1.0 to 3.0 $R_\odot$ from the solar center, at 10° intervals of longitude. (W.D.M.)

53956 HYDRODYNAMIC STUDY OF THE LARGE CORONAL STREAMER OBSERVED DURING THE ECLIPSE OF MARCH 7, 1970. Koutchmy, S. (Institut d'Astrophysique de Paris, France). Solar Phys.; 24: No. 2, 373-84(Jun 1972). (In French).

Photometry of the large coronal streamer located on the N–E limb of the Sun observed on March 7, 1970 in Mexico was performed using compensated plates in unpolarized light as well as in tangentially and radially polarized light. The measured polarizations locate the streamer in space using a generally used method. The density distribution in the core of the streamer and for $r > 1.5\ R_\odot$ is given as well as the half-widths of the density distribution perpendicular to the axis of the streamer. Densities n(r) in the $1(R_\odot) < r < 1.5(R_\odot)$ region were obtained assuming hydrostatic equilibrium (4) for $1.5 < r < 2$. The axial values of n(r) are given which agree with those of other models. The values of parameters for the model given are tabulated. The variation of the expansion velocity was derived from the hydrodynamical continuity equation. This velocity becomes supersonic [$\nu > 150$(km s^{-1})] above the height of minimum cross section of the streamer, $r = 3.5\ (R_\odot)$. This result was verified by a simple calculation based on the observed curvature of the streamer's "stalk." The velocity corresponding to the garden hose effect considered had a lower value equal to 60 (km s^{-1}). The radial distribution of the expansion velocity is shown. The model allows one to extrapolate in order to obtain the value of $\nu(r)$ at the Sun's surface. This value, $\nu \approx 0.07$ (km s^{-1}) can be compared with the value of the differential rotation velocity of the "foot" of the streamer. The values of the corpuscular flux of the streamer were calculated [$F = 2.4 \times 10^{34}$(e s^{-1})] and agreed with the value of the flux corresponding to the density enhancements of the solar "wind", measured in situ. This shows the importance of large streamers for the coronal expansion processes. (auth)

53957 CORONAGRAPHIC OBSERVATIONS OF AN ENHANCED CORONAL REGION. II. TEMPERATURE AND DENSITY STRUCTURE THROUGH THE ENHANCED REGION. Fisher, Richard R. (Univ. of Hawaii, Honolulu). Solar Phys.; 24: No. 2, 385-94(Jun 1972).

Ratios of emission line intensities were used to calculate the variation of temperature and the variation of electron density as a function of ion class for differing paths through a coronal enhancement. The data indicated (a) a peak mean electron density of 2.3×10^9 cm^{-3}, (b) a temperature maximum greater than 2.3×10^6 K, and (c) the noncoincidence of the peak temperature and peak mean electron density. The latter demonstrates the invalidity of the assumption of symmetric models for coronal enhancements. The abundance of Ni was found to be equal to 0.045 that of Fe from the line ratio I(λ 6702)/I(λ 7059) and a density model based on the variation of the ratio I(λ 8024)/I(λ 6702). (auth)

53958 PHOTOGRAPHS OF THE SUN IN THE XUV REGION. Burger, M.; Dijkstra, J. H. (Astronomical Inst., Utrecht). Solar Phys.; 24: No. 2, 395-404(Jun 1972).

X-ray photographs obtained with a zone plate camera on October 3, 1967 in the wavelength band 49.5 to 52.5 Å were investigated photometrically. The most intense x-ray emission corresponded with active regions in Hα and Ca II. About one quarter of the total solar flux was emitted by the three brightest x-ray sources (A, E and J). X-ray emission from quiet regions was also observed. Limb brightening was found, also at the poles, which indicated a higher electron density at the poles than during solar minimum. The brightest x-ray regions had a very small core of the order of 20″. No relation to magnetic field strengths of sunspots was found. However, a correlation with active prominences cannot be ruled out. X-ray source A was related either to prominence activity or to flare activity. One x-ray region (J) was probably related to flare activity. Assuming an electron temperature of 3 to 5×10^6 K for coronal active regions an emission measure of a few times 10^{49} cm^{-3} was derived, which yielded an electron density of a few times 10^{10} cm^{-3}. (auth)

53959 OBSERVATIONS AND COMMENTS FOR THE SOLAR EVENT OF OCTOBER 24, 1969. Covington, Arthur E. (National Research Council of Canada, Ottawa). Solar Phys.; 24: No. 2, 405-10(Jun 1972).

Observations of the flare of October 24, 1969 by Zirin et al. (1971) Solar Phys. 19, 463, are given with accompanying graphs of XUV emissions from satellites and four microwave radio emissions from Sagamore Hill Observatory. This event provides an excellent example of the development of two types of radio spectra within the same center and similar profiles for the hard x-ray burst and the 8800 MHz radio profile. The examination of the 2700 MHz burst from the Dominion Radio Astrophysical Observatory provides a clarification of the radio profile and shows the existence of a long enduring burst not previously considered. This event parallels a similar variation of intensity in the soft x-ray burst. (auth)

53960 MEASUREMENT OF THE ELECTRON TEMPERATURE OF SMALL 3-CM RADIO BURSTS. Foukal, Peter (Carnegie Institution of Washington, D. C.). Solar Phys.; 24: No. 2, 411-13(Jun 1972).

An attempt was made to correlate low-amplitude radio bursts at 3 cm with transient features on Hα films. (W.D.M.)

53961 THICK-TARGET PROCESSES AND WHITE-LIGHT FLARES. Hudson, H. S. (Univ. of California, San Diego, La Jolla). Solar Phys.; 24: No. 2, 414-28(Jun 1972).

Observations indicate that fast electrons in solar flares, which cause the hard x-ray burst and the impulsive microwave burst, lose energy predominantly by collisional processes. This requires a thick-target theory of the emission, for which the electron spectrum inferred from the x-ray spectrum becomes 1.5 powers steeper than in the usual thin-target theory. The low-energy end of this spectrum contains enough energy above about 5 keV to supply the white-light continuum emission occasionally observed in major flares. The penetration of the nonthermal electrons creates long-lived excess ionization which enhances

the free–free and free–bound continuum in the heated medium. The emission will occur high above the photosphere at small optical depth in the visible continuum. Thus its spectrum will extend into the infrared and ultraviolet. (auth)

53962 NEW MEASUREMENTS OF THE POLARIZATION OF X-RAY SOLAR FLARES. Tindo, I. P.; Ivanov, V. D.; Mandel'stam, S. L.; Shuryghin, A. I. (Lebedev Inst. of Physics, Moscow). Solar Phys.; 24: No. 2, 429-33(Jun 1972).

Measurements of three x-ray flares in October/November 1970 aboard the Intercosmos 4 satellite confirm the existence of polarization in the initial phase of the x-ray bursts. The polarization can be observed for a few up to ten minutes, and an increase in polarization is observed during secondary maxima of the bursts as well. (auth)

53963 SOLAR SOFT X RAYS AND SOLAR ACTIVITY. II. OBSERVATIONAL ASSESSMENT OF THE ROLE OF THE TYPE III ACCELERATION MECHANISM IN ESTABLISHMENT OF THE SOFT X-RAY SOURCE VOLUME. Teske, Richard G. (Univ. of Michigan, Ann Arbor); Thomas, Roger J. Solar Phys.; 24: No. 2, 434-43(Jun 1972).

Peak fluxes of flare-associated 8- to 12-Å x-ray bursts occur at or near the time of the maximum energy content of the soft x-ray source volume. The amplitudes of flare-associated bursts may thus be used as a measure of the energy deposited in the source volume by nonthermal electrons and other processes. In the mean, the soft x-ray burst amplitude is apparently independent of the occurrence of a Type III event. This is interpreted to indicate that electrons accelerated by the Type III process do not directly participate in establishing the soft x-ray source volume. (auth)

53964 DYNAMIC THEORY OF TYPE-III SOLAR RADIO BURSTS. Zaitsev, V. V.; Mityakov, N. A.; Rapoport, V. O. (Inst. of Radiophysical Research, Gorky, USSR). Solar Phys.; 24: No. 2, 444-56(Jun 1972).

Numerous experimental data indicate that Type III solar radio bursts are generated by the streams of fast electrons in the corona. The process of the electron acceleration in the flare region is, in general, of the character of a short time local explosion. As a result, a spatially limited stream with inhomogeneous front and back is formed in the corona. It is shown that such a spatial structure of fast electrons radically changes the dynamics of the stream instability development. In particular, for example, despite strong quasilinear relaxation, in this case the electron stream can generate plasma waves in the corona for a long time due to faster electrons escaping out of the front of the stream. The extension of the stream in the outer corona where the collisions are negligible is of similar character. The maximum of the energy density in the packet of excited plasma waves travels in the corona with constant mean velocity which is defined by the fast-electron energy at the moment of their formation in the flare region. Therefore, in spite of the considerable influence of quasilinear effects on the stream motion, the velocity of Type III sources found in terms of the drift velocity remains unchanged. This creates the illusion of stream stabilization. The energy dissipation of plasma waves for the low-frequency Type III bursts is fully determined by Landau damping in the tail of the stream. Because of this, the temperature estimates of the outer corona from time profiles of Type III bursts are incorrect. The theoretical curves of the time variation of radiation at different frequencies agree well with the experimental data in the hectometer wave range under the assumption that the electromagnetic wave generation takes place at the second harmonic of the plasma frequency. In this case it is necessary to decrease the electron density in the solar corona at distances of about 5 to 30 $R_\odot$ 4 times as compared with the densities previously derived from Type III data. (auth)

53965 TIME BEHAVIOUR OF THE CONTINUA DURING THE INITIAL STAGE OF TYPE-IV BURSTS. Boehme, A. (Zentralinstitut fuer Solar-Terrestrische Physik, Potsdam, Ger.). Solar Phys.; 24: No. 2, 457-74(Jun 1972).

The existence of a group of broad-band continua during the initial stage of some Type IV bursts can be shown which are polarized in the extraordinary sense. Unfortunately interferometric records were available only for one of these continua. In this case no movement of the radiation source could be stated during the whole of its lifetime. It can be shown that the time behavior of the broad-band continua is clearly different from that of the moving Type IV bursts recorded directly by interferometers. Therefore, it must be concluded that both types of continua originate from different physical processes at the Sun, though both are caused by synchrotron radiation. (auth)

53966 CHANGE OF SOLAR-FLARE PROTON-TO-ALPHA RATIOS DURING AN ENERGETIC STORM PARTICLE EVENT. Scholer, M.; Hovestadt, D.; Hausler, B. (Max-Planck-Institut fuer Physik und Astrophysik, Munich). Solar Phys.; 24: No. 2, 475-82(Jun 1972).

Observations of the temporal behavior of energetic storm protons and alpha particles are presented for the event associated with the sudden storm commencement observed on Earth on March 8, 1970. The data were obtained on board the low-altitude polar orbiting satellite GRS-A/AZUR by means of two particle telescopes. Large changes in the proton to alpha ratios for particles of equal energy and for particles of equal energy per nucleon were observed, whereas no significant changes in the equal energy per charge ratio were observed. Electric fields, Fermi acceleration, and cyclotron resonance are discussed as possible modulation mechanisms. (auth)

53967 SEARCH FOR NEUTRONS OF SOLAR ORIGIN USING BALLOON-BORNE DETECTORS: 1967–69. Eyles, C. J.; Linney, A. D.; Rochester, G. K. (Imperial Coll. of Science and Tech., London). Solar Phys.; 24: No. 2, 483-97(Jun 1972).

A series of telescopes having approximately a 30° half opening angle and responding to neutrons in the energy range 50 to 350 MeV has been flown to the top of the atmosphere on balloons released from an equatorial launching site at Kampala, Uganda, between 1967 and 1969. The aim of the experiment was to attempt to detect solar neutrons during periods of enhanced solar activity. No neutrons of solar origin were detected, but an upper limit of the order of 30 neutrons m^{-2} s^{-1} at the Earth has been placed on the continuous solar neutron flux in the above energy range, and a limit of four photons m^{-2} s^{-1} has also been placed on the corresponding γ-ray flux above 80 MeV. Limits have likewise been placed on the total emission from various flares. For a 1B flare the values were 23×10^4 neutrons m^{-2} and 6×10^4 photons m^{-2}. (auth)

53968 RELATIVISTIC ELECTRONS ASSOCIATED WITH SOLAR FLARES. Sakurai, Kunitomo (Goddard Space Flight Center, Greenbelt, Md.). Planet. Space Sci.; 20: No. 8, 1229-34(Aug 1972).

Solar flares that produce relativistic electrons generally occur within sunspot groups that are active in the emission of meter type-I noise storms. It is suggested that relativistic electrons in solar flares are accelerated from the keV-energy electrons responsible for the type-I noise storms. The relationship between flare developments and the ejection of keV electrons is briefly considered. (auth)

53969 DENSITY DEPENDENT IONIZATION BALANCE OF CARBON, OXYGEN, AND NEON IN THE SOLAR ATMOSPHERE. Summers, Hugh P. (Univ. of Bristol, Eng.). Mon. Notic. Roy. Astron. Soc.; 158: No. 3, 255-75(1972).

Density dependent ionization equilibria for carbon, oxygen, and neon ions in the optically thin solar atmosphere are calculated. All relevant processes are included and the results are expected to be accurate to ~40%. Except for the neutral and first ionized ions in each case, the results are applicable to the ionization equilibrium in any thermal plasma where the ionization is maintained by the free electrons. Fractional ion abundances on incorporating a chromosphere and corona model are also presented. (auth)

53970 COMPARISON OF SOLAR-FLARE ENERGY ESTIMATES MADE BY ANALYTICAL AND NUMERICAL TECHNIQUES. Dryer, Murray (National Oceanic and Atmospheric Administration, Boulder, Colo.). J. Geophys. Res.; 77: No. 25, 4851-4(1 Sep 1972).

The mechanical energy release of several solar flares is estimated by analytical and numerical methods. Analytical estimates, made originally by M. Dryer and D. L. Jones (1968) using similarity blast-wave theory, are corrected and compared with those based upon numerical studies of A. J. Hundhausen and R. A. Gentry (1969). Complete agreement is found in a limited study of three events in the original investigation, which assumed that the shock waves observed at 1 AU were blast waves. As a result of this study, it is suggested that the July 7, 1966 (0026 UT), solar flare may, instead, have produced a piston-driven shock wave. Some of the relative advantages and disadvantages of the similarity and numerical techniques (limited to the blast case only) are discussed. (auth)

Galaxies

Refer also to abstracts 53815 and 53880.

53971 APERTURE SYNTHESIS OBSERVATIONS OF NEUTRAL HYDROGEN IN THREE GALAXIES. Shostak, Gerson

Seth. Pasadena, Calif.; California Inst. of Tech. (1972). 233p. University Microfilms Order No. 72-22,613.

Thesis.

Aperture synthesis techniques were used to study the three galaxies NGC2403 (Scd), NGC4236 (SBdm), and IC10 (Irr) in the 21-cm line of neutral hydrogen and off-line continuum. Spatial resolution was 2 minutes of arc; velocity resolution was 21 km-s^{-1} The data yield information on the distribution of the HI, and its associated velocity field. Hydrogen extent of the objects agreed well with their optical size, and evidenced a lumpy structure. HI peaks occur away from the nuclei for NGC2403 and NGC4236, and are suggestive of a ring structure for the former galaxy. The hydrogen distribution of IC10 is similar in appearance to that of the Small Magellanic Cloud. In all objects HI peaks show good positional agreement with major HII regions. Velocity fields were derived for all objects, and rotation curves obtained for NGC2403 and NGC4236. These curves evidenced differential rotation but did not include Keplerian tails, implying that the mass distributions are considerably extended and the total masses poorly determined. The velocity field of IC10 suggests rotation. Noncircular motions of ~10 km-s^{-1} were seen in NGC2403, and these agreed well with the streaming motions predicted by the density-wave theory of spiral structure. A comparison of NGC2403 with the late-type spirals M33 and M101 revealed a progressive deepening of the central HI depression with increasing mass. Rotation curves for these three galaxies are similar, and consequently all are expected to have mass-to-light ratios which increase rapidly with radius. All have similar maximum HI surface densities (~10^{21} atoms-cm^{-2}) and observed fractional hydrogen masses (~9%). (Diss. Abstr. Int., B)

53972 GROSS PROPERTIES OF FIVE Scd GALAXIES AS DETERMINED FROM 21-CENTIMETER OBSERVATIONS. Rogstad, D. H.; Shostak, G. S. (California Inst. of Tech., Pasadena). Astrophys. J.; 176: No. 2, 315-21(1 Sep 1972).

Neutral-hydrogen studies of the five Scd galaxies M33, NGC 2403, IC 342, M101, and NGC 6946 revealed substantial similarities in their hydrogen distributions and rotation curves. It was found that ~80% of the observable H I lies within the boundary defined by the Holmberg diameter for each galaxy. The ratio of the H I mass to the total mass contained within this same boundary had a mean value of ~0.11. The central H I surface density was also nearly constant within the Scd classification. It was found that all the H I global properties and ratios are nearly constant or scale approximately with Holmberg radius or total mass. An observed correlation of maximal rotation velocity with Holmberg radius allowed characterization of the total mass with only one parameter. Because of the very flat rotation curves observed for these Scd galaxies, total masses extrapolated to infinite radius are not known. Surface mass–luminosity ratios must reach values of ~20 at the Holmberg radius. (auth)

53973 GALACTIC ORIGIN FOR THE SOFT X-RAY BACKGROUND. Gorenstein, Paul; Tucker, Wallace H. (American Science and Engineering, Cambridge, Mass.). Astrophys. J.; 176: No. 2, 333-44(1 Sep 1972).

The results of a new observation of the soft x-ray background in the Virgo region with high angular resolution are reported. Using results from this and previous observations, the following observational features for the background were derived: (a) the intrinsic emission spectrum of the background is quite soft, for an exponential spectrum KT ≤ 0.1 keV, (b) the ratio of the pole to plane flux decreases with energy below 0.28 keV, and (c) the diffuse flux in the Virgo region has a granularity of ~14% in regions of 4.5 square degrees. No evidence was found which supports the hypothesis of an extragalactic component for any substantial portion of the background. Assuming that the diffuse flux arises entirely from a galactic distribution of point sources, features indicating that the scale height of the distribution is ~800 pc, the number density is ~10^{-2} (pc)$^{-3}$, and the effective temperature and luminosity of individual sources are ~10^6 °K and 3×10^{30} ergs s^{-1}, respectively, were derived. These requirements might be satisfied by radiation from a hot plasma produced by accretion onto disk and/or intermediate Population II stars in close binary systems. (auth)

53974 NEW METHOD FOR ESTIMATING THE HUBBLE CONSTANT. van den Bergh, Sidney (Univ. of Toronto, Richmond Hill). Astron. Astrophys.; 20: No. 3, 469-70(Sep 1972).

Radio observations of galactic supernova remnants indicate that the mean interval between supernova outbursts in the Galaxy is 50 ± 25 y. Comparison of this value with Tammann's determination of the frequency of supernovae in distant spirals yields H = 95 ± 36 km s^{-1} Mpc^{-1}. (auth)

53975 ORIGIN AND FORM OF THE GALACTIC MAGNETIC FIELD. II. THE PRIMORDIAL-FIELD MODEL. Piddington, J. H. (National Standards Lab., Sydney). Cosmic Electrodyn.; 3: No. 2, 129-46(Jul 1972).

A primordial field (10^{-9} to 10^{-8} G) is required to account for the magnetic fields of galaxies. Making random angles with the galactic rotational vectors it may thus account for the different galactic forms and degrees of central activity. In spiral galaxies the two vectors are oblique, leading to moderate activity and spiral structure. The oblique rotator model of the galactic disk field and halo explains the radio continuum emission and the fact that the disk field and cosmic rays are gravitationally contained even in regions of low gas density. Further observational evidence includes metagalactic Faraday rotation, intergalactic "bridges", and the magnetic field system of the Magellanic clouds. Two questionable assumptions made two decades ago have persisted: that because there is no dust between the spiral arms of M31 there can be no gas, and that the H I gas concentrations seen in our Galaxy are parts of spiral arms. These assumptions have led to the rejection of hydromagnetic theories of spiral arms and the wide acceptance of the Lin–Shu density wave theory. It is shown that the first assumption is incorrect and the second probably incorrect so that the wave theory has no observational support and a magnetic model is not excluded. A hydromagnetic theory of twin spiral arms is based on gas motions mainly perpendicular to the disk caused by a field whose tilt varies sinusoidally with rotation. Star formation is controlled by gas streaming obliquely along field lines in the manner described by Parker. The modes of formation of gas rings and bars are also discussed. (auth)

53976 AGE AND STRUCTURE OF II ZWICKY 40. Jaffe, W. J. (Sterrewacht te Leiden). Astron. Astrophys.; 20: No. 3, 461-4(Sep 1972).

The dwarf galaxy II Zw 40 was detected at 1415 Mhz continuum with the WSRT. The measured flux density, combined with previous H I measurements, indicates a diameter of about 1 kpc. The kinetic energy of the galaxy seems primarily nonrotational, and the system is probably less than 10^7 years old. (auth)

53977 QUADRATIC PROGRAMMING APPLIED TO THE PROBLEM OF GALAXY POPULATION SYNTHESIS. Faber, S. M. (Harvard Univ., Cambridge, Mass.). Astron. Astrophys.; 20: No. 3, 361-74(Sep 1972).

The technique of quadratic programming as applied to the problem of galaxy population synthesis is described. The method offers significant advantages over the trial-and-error approach usually employed. This technique is applied to 38-color data on the nuclei of M 31, M 32, and M 81 and to integrated 10-color photometry for elliptical galaxies. The results indicate that estimates of mean line strengths in external galaxies by means of population synthesis are well determined. Ages based on the main-sequence turnoff point are uncertain by a factor of two. The method is not sensitive to the number of stars on the main sequence between K 0 V and M 7 V. Consequently the slope of the luminosity function below turnoff cannot be determined. The mass-to-light ratio of the computed population for M 31 is uncertain by a factor of 4. The corresponding factors for M 32 and M 81 are 50 and 16 respectively. Models for elliptical galaxies suggest that the mean metal abundance of the stellar population increases with increasing galaxy luminosity. (auth)

53978 GALACTIC EVOLUTION: PROGRAM AND INITIAL RESULTS. Tinsley, Beatrice M. (Univ. of Texas, Dallas). Astron. Astrophys.; 20: No. 3, 383-96(Sep 1972).

A program is described for studying the evolution of galaxies. Some initial results are presented, suggesting future applications of the program. In the models, stars are formed from interstellar gas, and the evolution of each star is followed from the main sequence to death. Semi-empirical tracks based on old open clusters and old-disk moving groups are used for the later stages of low-mass stars. Properties of the models that can be calculated at times from 1 to 11 × 10^9 years (in discrete time steps of 10^9 yr) are: the detailed stellar population at 566 points of the H–R diagram; the mass of gas and its helium and metal content; the bolometric magnitude; integrated broad-band colors and magnitudes on Johnson's 8-color system; the mass to light ratio; the uv flux at 1700 Å; integrated intermediate-band colors on McClure and van den Bergh's system; narrow-band colors on Wood's system; and narrow-band scanner colors and indices on Spinrad and Taylor's system. The models studied are homogeneous and contain solar-composition stars only. Metal-poor and super-metal-rich stars can be added (as integrated globular clusters and SMR K giants) to a computed population before its photometric properties are found. Stellar birthrates used include a variety of initial luminosity functions and functions of time or gas mass. These functions provide a set of

models with which to survey the potentialities of the method. Future studies will use birthrate functions based on theories of star formation in various types of galaxies. Models discussed were not planned to match any galaxy precisely, but the types of birthrate required for various typical galactic populations, and their overall evolution, are clearly indicated. Some results of interest are: (1) Models evolve redwards along the observed galactic 2-color relation, so UBV colors cannot tell if a galaxy contains only, or just predominantly, young stars. (2) The observed far ultraviolet flux could arise from young main sequence stars, in galaxies with a finite present birthrate. (3) Super metal-rich stars are probably formed in elliptical galaxies and the central regions of spirals. (4) The infrared light of galaxies is predicted to be dominated by late giants, even in systems with a high mass-to-light ratio, (5) The Spinrad–Taylor indices are far the most sensitive of the properties studied to the distribution of stellar temperatures, luminosities, and abundances in a population. Use of broad-band colors alone can be seriously misleading. (auth)

53979 ANGULAR DISTRIBUTION OF INTERSTELLAR ATOMIC HYDROGEN. Daltabuit, E.; Meyer, S. (Univ. of Wisconsin, Madison). Astron. Astrophys.; 20: No. 3, 415-24(Sep 1972).

A summary of recent values of the columnar density of galactic atomic hydrogen appearing in the literature is presented in the form of plots of N_H vs $\cdot$ l^{II} for every 5° in galactic longitude. (auth)

53980 GALAXY FORMATION IN ANISOTROPIC COSMOLOGIES. Perko, T. E.; Matzner, R. A.; Shepley, L. C. (Univ. of Texas, Austin). Phys. Rev., D; 6: No. 4, 969-83(15 Aug 1972).

The growth rates of perturbations of the generic dust-filled Bianchi type-I cosmology (which exhibits anisotropy but not rotation) are analyzed. Anisotropy induces coupling between gravitational wave and density modes and can enhance the power-law rate of growth of the density perturbations. A maximum growth rate for pregalaxy perturbations is $t^{\frac{1}{3}}$ (where t is cosmic time), so that no conclusive solution to the galaxy formation problem is found. The detailed structure of the flow of energy between gravitational wave and density modes and of the growth of rotational modes (decoupled from other perturbations) is presented. A detailed discussion is also given of the gauge-invariance properties of these perturbations. (auth)

53981 GALACTIC ASTRONOMY. VOLUME 1. Proceedings of the Summer Institute for Astronomy and Astrophysics, Held at Stony Brook, New York, Summer 1968. Chiu, Hong-yee; Muriel, Amador (eds.). New York; Gordon and Breach, Science Publishers, Inc. (1970). 340p.

Separate abstracts were prepared for the six chapters. (W.D.M.)

For abstracts of individual chapters see: 53982–53987.

53982 BASIC PROBLEMS ON THE STRUCTURE AND DYNAMICS OF OUR GALAXY. Bok, Bart J. (Univ. of Arizona, Tucson). pp 1 of Galactic Astronomy. Vol. 1. /Chiu, Hong-yee (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1970).

Topics covered include: recent history and outline of the Galaxy; basic data (spectral classification, photometry, photography, proper motions, parallaxes, and radial velocities); moving clusters; calibration problems; kinematics of stellar motions (galactic rotation, solar motion, ellipsoidal distributions of peculiar motions, asymmetry of stellar motions, and Bottlinger's diagram); Lindblad's epicyclic orbits; principles of galactic dynamics; dynamics of star clusters. (W.D.M.)

53983 SPIRAL STRUCTURE OF GALAXIES. Oort, J. H. (Univ., Leiden). pp 121-45 of Galactic Astronomy. Vol. 1. /Chiu, Hong-yee (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1970).

Lectures included in this section were spiral structure of the Galaxy as determined from 21-cm line observations, central region, observations of high-velocity clouds, and origin of the high-velocity clouds. (W.D.M.)

53984 GALACTIC RADIO EMISSION IN THE 21-CM LINE AND THE CONTINUUM. Westerhout, G. (Univ. of Maryland, College Park). pp 147-90 of Galactic Astronomy. Vol. 1. /Chiu, Hong-yee (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1970).

Topics covered include historical introduction to radio astronomy, fundamentals of 21-cm line emission, galactic rotation from 21-cm line emission, large-scale distribution of hydrogen, clouds and small-scale structure, hydrogen distribution in Galaxy and solar neighborhood, and the galactic continuum. (W.D.M.)

53985 SELECTED TOPICS ON THE PHYSICS OF THE INTERSTELLAR MEDIUM. Muench, G. (California Inst. of Tech., Pasadena). pp 191-243 of Galactic Astronomy. Vol. 1. /Chiu, Hong-yee (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1970).

Interstellar absorption (optical lines) is considered in terms of modern observing techniques, optical interstellar spectrum, ultraviolet spectrum, structural model for interstellar medium, kinematics of clouds, interpretation of line intensities, mean motions and densities of Na I and Ca II, internal velocity dispersion of clouds, ionization equilibrium, interstellar abundances, spectrum of ζ Oph, rocket uv spectrum, high-velocity clouds, high-galactic-latitude clouds, and the galactic corona. Problems related to the structure of planetary and galactic nebulae are treated including ionization stratification, spectra of emission nebulae, nebular absorption lines, and internal motions in emission nebulae. (W.D.M.)

53986 CEPHEID VARIABLES IN LARGE AND SMALL MAGELLANIC CLOUDS. Payne-Gaposchkin, Cecilia (Smithsonian Institution, Washington, D. C.). pp 245-329 of Galactic Astronomy. Vol. 1. /Chiu, Hong-yee (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1970).

Five lectures are presented on Cepheid variables in the Magellanic clouds and in the Milky Way. The significance of Cepheid studies is discussed. (W.D.M.)

53987 IRREGULAR SPIRAL STRUCTURE: CAUSES AND EFFECTS. Rickard, J. (Univ. of Maryland, College Park). pp 331-4 of Galactic Astronomy. Vol. 1. /Chiu, Hong-yee (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1970).

The problems caused by large-scale deviations from regular spiral structure in the Galaxy are discussed using the Cas–Per arm as an example. The possibility of super supernovae in spiral arms is considered. (W.D.M.)

53988 X-RAY EMISSION FROM INTERGALACTIC GAS IN THE NEIGHBOURHOOD OF GALAXIES. Hunt, R.; Sciama, D. W. (Oxford Univ.). Nature (London); 238: No. 5363, 320-3(11Aug 1972).

It is suggested that massive galaxies may have x-ray coronas associated with accretion of hot intergalactic gas. X-ray observations of Virgo A fit this hypothesis. Andromeda may also have an observable x-ray corona. (auth)

53989 RECENT WORK ON INTERSTELLAR GRAINS. Wickramasinghe, N. C. (Cambridge Univ., Eng.); Nandy, K. Rep. Progr. Phys.; 35: No. 2, 157-234(1972).

Observational data accumulated over the past decade have considerably narrowed down the choice of proposals for grain models. Mixtures of particles composed of refractory species such as graphite, silicates, quartz, and iron appear likely. Such particles may form in a wide range of astronomical situations, for example, cool stars, protostars, and supernovae explosions. Dust grains are responsible for infrared radiation in galactic sources, and also play an important role in the synthesis of interstellar molecules. (auth)

53990 EMISSION-LINE SPECTRUM OF CYGNUS A. Mitton, Simon; Mitton, Jacqueline (Cambridge Univ., Eng.). Mon. Notic. Roy. Astron. Soc.; 158: No. 3, 245-54(1972).

Spectra of Cygnus A taken at the Hale Observatories were analyzed. A line list of the nebular emission is presented. The results can be accounted for by a two-component model of the nucleus in which condensations at $T_e = 10^{4\cdot5}$K produce most of the emission lines; these condensations are embedded in a tenuous plasma at $T_e \approx 10^{6\cdot5}$K. A continuing source of excitation probably exists in the optical nucleus of this radio galaxy. (auth)

53991 NEW REDSHIFTS OF RADIO GALAXIES. Tritton, K. P. (Royal Greenwich Observatory, Hailsham, Eng.). Mon. Notic. Roy. Astron. Soc.; 158: No. 3, 277-80(1972).

Redshifts were obtained for 20 radio galaxies, including 0620-52, a new identification. (auth)

53992 DYNAMICAL MODELS OF THE GALAXY AND ITS GAMMA RAY EMISSION. Cowsik, R.; Hutcheon, I. D. (Univ. of California, Berkeley). pp 102-7 of 12th International Conference on Cosmic Rays, Hobart, Australia. Vol. 1. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From twelfth international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807–(Vol.1).

The intensity and angular distribution of gamma rays of E > 100 MeV emitted by the galactic disc is explained. The model is based

on the spatial distribution of stars required to explain the dynamical properties of the Galaxy. The gamma rays are postulated to arise from the Compton scattering of starlight by cosmic-ray electrons. This calculation also supports the idea that the cosmic-ray density in the Galaxy is reasonably uniform. The implications of this result are briefly discussed. (auth) (Australia)

Cosmology

Refer also to abstracts 53974 and 54396.

53993 (INIS-mf-252) THE NUCLEUS. Annual Review of the Science Foundation for Physics and the School of Physics Within the University of Sydney. (Sydney Univ. (Australia)). Jan 1972. 84p. INIS.

Various activities of the Science Foundation for the year 1971 are reviewed. Brief summaries are made of projects being undertaken by the theoretical physics, nuclear research, computer science, plasma physics, astronomy, and astrophysics departments at Sydney University. (Australia)

53994 STATISTICAL STUDIES OF THE EVOLUTION OF EXTRA-GALACTIC RADIO SOURCES. I. QUASARS. Schmidt, Maarten (California Inst. of Tech., Pasadena). Astrophys. J.; 176: No. 2, 273-87(1 Sep 1972).

Radio source counts attributable to quasars were derived on the assumption that their redshifts are cosmological. Evolution effects seen in the statistics of both optically selected quasars and identified quasi-stellar radio sources are consistent with density evolution or appropriately optical luminosity-dependent density evolution. Two alternative laws for density evolution, $\rho = 10^{5\tau}$ and $\rho = (1+z)^6$, were adopted. Statistics of high-redshift quasars suggest that the density cannot increase beyond redshift 2.5. An earlier result that the radio luminosity function depends on optical luminosity such that the ratio R has a universal distribution function was adopted. An attempt was made to determine this function and then derive quasar source counts, redshift–flux density tables, and a magnitude–flux density table. The predicted quasar source counts are quite similar for the two alternative density laws. A comparison with general counts of extragalactic radio sources at 408 MHz shows that quasars contribute between 20 and 30%, with little dependence on flux density. (auth)

53995 STATISTICAL STUDIES OF THE EVOLUTION OF EXTRA-GALACTIC RADIO SOURCES. II. RADIO GALAXIES. Schmidt, Maarten (California Inst. of Tech., Pasadena). Astrophys. J.; 176: No. 2, 289-301(1 Sep 1972).

Radio source counts attributable to radio galaxies and ordinary galaxies were derived. There was little direct evidence that radio galaxies show evolution. However, general radio source counts freed from the contributions of quasars and ordinary galaxies showed that radio galaxies must be subject to evolution. Since 5% of the giant elliptical galaxies are radio galaxies, a limit of a factor of 20 was imposed on the overall density increase of the latter with redshift. Neither this type of restricted density evolution nor luminosity evolution can explain the radio source counts attributed to radio galaxies. Two alternative luminosity-dependent density laws, $\rho = 10^{c\tau}$ and $\rho = (1+z)^k$, with exponents c and k smoothly increasing with radio luminosity are presented, that are compatible with the source counts. Extensive use was made of tables of redshift versus flux density that allow insight in the effect of luminosity function, density law, redshift cutoff, etc., on the source counts. (auth)

53996 STATISTICAL STUDIES OF THE EVOLUTION OF EXTRAGALACTIC RADIO SOURCES. III. INTERPRETATION OF SOURCE COUNTS AND DISCUSSION. Schmidt, Maarten (California Inst. of Tech., Pasadena). Astrophys. J.; 176: No. 2, 303-14(1 Sep 1972).

Radio source counts predicted on the basis of evolution models for quasars, radio galaxies, and ordinary galaxies are compared to observed total source counts at various radio frequencies. The observed increase with frequency of the fraction of sources with flat spectra is approximately reproduced in the evolution models. The predicted background temperature is slightly less than the observed value. Optical and radio luminosity functions are presented for quasars and radio galaxies. They depend strongly on the assumed type of density evolution law. At a redshift of 2.5 the space density of quasars appears to be of the same order as that of giant elliptical galaxies, the parent objects of radio galaxies. This may explain why the space density of quasars does not seem to increase beyond redshift 2.5. It is shown that certain arguments based on general source counts against the need for evolution or against the large distances of the sources are not supported by detailed evolution models. Finally the many uncertainties in the evolution models are emphasized; some of which can be resolved eventually by extensive optical and radio studies at low flux levels. (auth)

53997 PERTURBATIONS IN AN EXPANDING UNIVERSE OF FREE PARTICLES. Stewart, John M. (Inst. of Theoretical Astronomy, Cambridge, Eng.). Astrophys. J.; 176: No. 2, 323-32(1 Sep 1972).

In the canonical big-bang cosmology, one of the major energy sources in the temperature range $10^{10} > T > 10^5$ °K would be collision-free neutrinos. These might be expected to interact with gravitational radiation — including density perturbations, vorticity perturbations, and gravitational waves — in a radically different way from the usual cosmological models filled with collision-dominated radiation. The Jeans swindle, Newtonian cosmology, and relativistic cosmology are discussed using a kinetic-theory approach, and the same qualitative results are found in all three cases. Although perturbations on a scale larger than the horizon can grow, smaller ones are quickly dissipated. The mechanism is similar to Landau damping, and could not have appeared in the conventional hydrodynamic calculations. The effect may raise serious problems for theories of galaxy formation. (auth)

53998 SCALAR–TENSOR COSMOLOGY AND THE CLASSICAL TESTS. Luke, S. K.; Szamosi, G. (Univ. of Windsor, Ont.). Astron. Astrophys.; 20: No. 3, 397-405(Sep 1972).

The scalar–tensor field equations for the matter Universe are solved numerically by a self-consistent method. The rate of change of the scalar field at the present epoch is limited to $3.0 \times 10^{-11} > \phi_0^{-1} (d\phi/dt)_0 > 8.0 \times 10^{-13}$ year^{-1} by recent observation and the present calculation respectively. The three classical tests of cosmology are calculated for a range of the parameters ρ_0 and $(d\phi/dt)_0$. Comparing observational data with theory suggests that the absolute visual magnitude of the first rank galaxy is -22, the cosmic density is of the order 10^{-30} g cm^{-3}, and the average linear diameter of the galaxies is 4.3 kpc. No definite conclusion about world models can be drawn from the presently available data. If the redshifts of the quasi-stellar objects are cosmological, it is not possible to construct a Brans–Dicke model to fit the redshift–magnitude data without luminosity evolution. (auth)

53999 EXACT EXPRESSIONS FOR THE PROPERTIES OF THE ZERO-PRESSURE FRIEDMANN MODELS. Edwards, Dilwyn (Thames Polytechnic, London). Mon. Notic. Roy. Astron. Soc.; 159: No. 1, 51-66(1972).

Exact expressions in terms of Jacobian Elliptic Functions are obtained for the properties of the expanding singular cosmological models of the Friedmann kind, assuming zero pressure and a general cosmological constant. (auth)

54000 COMMENT ON INVERSE COMPTON MODELS FOR THE ISOTROPIC X-RAY BACKGROUND. Cowsik, R.; Kobetich, E. J. (Univ. of California, Berkeley). pp 38-43 of 12th International Conference on Cosmic Rays, Hobart, Australia. Vol. 1. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From twelfth international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807–(Vol.1).

An exact calculation of the spectrum of the isotropic background x radiation was made assuming that it arises through the Compton scattering of the universal microwave photons by the relativistic electrons leaking out of the Galaxies. The elegant fit to the experimental data obtained by earlier authors who made many approximations in their calculations disappears in the exact treatment presented here. It is felt that the "Inverse Compton" models for the origin of background x rays are therefore not yet adequate to explain all the spectral features in detail. (auth) (Australia)

Planetary Phenomena

54001 (NASA-TM-X-2440, pp 556-60) JUPITER RADIATION-BELT ENGINEERING MODEL. Divine, Neil (California Inst. of Tech., Pasadena). Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

On the basis of earth observations of the hf and uhf radio emission generated near Jupiter, the presence of energetic charged particles trapped in the planet's dipole magnetic field was inferred. For electrons, energies of the order of 10 MeV and peak fluxes of the order of 10^7 cm^{-2} s^{-1} can be derived from the data for equatorial regions about two planetary radii from the dipole. Energetic protons and lower-energy electrons and protons are also expected, but the limited data require that their fluxes be

based on theory or earth analogy. Because descriptions available in the literature suggest large associated uncertainties, both nominal and limiting models for the charged-particle populations of Jupiter's belts are derived. These new engineering models describe electron and proton fluxes and their distributions in energy and position in forms suitable as space vehicle design criteria. (auth)

54002 (NASA-TM-X-2440, pp 781-4) JUPITER RADIATION TEST LEVELS AND THEIR EXPECTED IMPACT ON AN ENCOUNTER MISSION. Barengoltz, J. B. (California Inst. of Tech., Pasadena.). Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

Upper limit electron and proton fluences for a Thermoelectric Outer Planet Spacecraft (TOPS) mission in a near-Jupiter environment, for use as radiation design restraints, are extracted from the JPL engineering model of the Jovian trapped-radiation belts. Considerations of radiation effects in semiconductor devices are employed to construct simplified radiation test levels based on the design restraints. Corresponding levels, based on the nominal belt models, are found to be one to three orders of magnitude smaller. In terms of expected radiation-induced degradation in semiconductor devices, an encounter with an environment as severe as the design restraints would require hardening the system in order to guarantee high reliability. On the other hand, the nominal levels would only necessitate care in the selection of components and the avoidance of certain discrete semiconductor piece-parts. (auth)

54003 STATISTICAL MECHANICS OF LIGHT ELEMENTS AT HIGH PRESSURE. II. HYDROGEN AND HELIUM ALLOYS. Hubbard, W. B. (Univ. of Texas, Austin). Astrophys. J.; 176: No. 2, 525-31(1 Sep 1972).

A Monte Carlo method described in a previous paper is used to evaluate various thermodynamic quantities for hydrogen–helium mixtures at temperatures and pressures characteristic of the Jovian interior. The additive-volume law for chemical mixtures appears to be an excellent approximation. However, the Debye equation of state for the temperature dependence of the pressure is rather crude and tends to overestimate the pressure for a given temperature and density. (auth)

54004 ELECTRODYNAMIC EFFECTS OF JUPITER'S SATELLITE Io. Piddington, J. H. (CSIRO, Sydney). Cosmic Electrodyn.; 3: No. 2, 240-53(Jul 1972).

The motion of Jupiter's satellite Io in the magnetosphere creates a disturbance which provides the decametric radio emission. Recent measurements tend to confirm a disturbance model in which a magnetic force tube is partially frozen into Io and so moves through the ionosphere almost as a solid in a fluid. Ambipolar drift deposits ions and electrons in the equatorward boundary layers of Io's force tube in the ionosphere; a density of 10^7 electrons cm^{-3} seems possible. The propagation time of the hydromagnetic disturbance from Io to the ionosphere and back is found to be about one third the previous estimate. This greatly reduces the required electrical conductivity of Io. The deformation of the force tube and the power transmitted are revised because of the effects of Hall current. The new disturbance model provides the radio emissions by plasma oscillations from a dense sheet of ions and electrons on the surface of Io's force tube in the lower ionosphere. It also suggests that Jupiter's Van Allen belts are powered by the Io disturbance, and that a Jupiter space probe should be directed at Io's force tube. (auth)

54005 FORMATION OF PLANETS FROM A SOLAR NEBULA. Lyttleton, R. A. (California Inst. of Tech., Pasadena). Mon. Notic. Roy. Astron. Soc.; 158: No. 4, 463-83 (1972).

The development of planets within a solar nebula of both gas and dust is shown to occur in two main stages. First, in a time comparable with the orbital period at any distance the dust comes to move with Keplerian motion in a thin plane disc. This is an essential prerequisite since the volume–density in such a disc is amply sufficient for the self-gravitation of condensations to overcome the differential action of the Sun. By such means small solid planets can form independently of the gaseous component of the nebula. Second, the range-of-influence of a planet (of mass m moving at distance R) out to which its gravitation dominates over that of the Sun is $(m/3M)^{\frac{1}{5}}R$. At any stage material within this distance can be captured, and the growth of bodies to mass of lunar order requires about 10^4 yr. It seems probable that many small bodies would begin to form separately, and then themselves combine any collisions to yield larger bodies fewer in number. The vorticity associated with the motion of the disc round the Sun will reappear as angular momentum of the bodies and give them initial rotation periods of about 4 to 5 hr, but collisions would tend to give the later larger masses longer periods of rotation. The energy of infall to the surface would be sufficient to melt the material for bodies as large as the Moon, but it would arrive only at an equatorial band because of the thinness of the dust-disc, and flow of molten material polarwards would produce a condition highly conducive to cooling. If larger masses than of lunar order result mainly from collisions, it seems probable that initially only all-solid planets would be formed. The great outer planets must also start their growth within the dust-disc as small solid bodies and thereafter they would continue growth by capture of gaseous material from the nebula. Only for Jupiter is capture of gas in accordance with thermal accretion likely to have occurred, since only for it could the accretion radius ever exceed the range of gravitational influence. (auth)

54006 LIMITS TO ENERGETIC PROTON FLUXES TRAPPED IN JUPITER'S MAGNETOPSHERE. Mihalov, J. D. (Ames Research Center, Moffett Field, Calif.). Planet. Space Sci.; 20: No. 8, 1345-7(Aug 1972).

Fluxes of energetic electrons (E ~ 10 MeV) trapped in Jupiter's magnetic field were inferred from measurements at Earth of the decimetric synchrotron radio noise flux. Energetic trapped protons should be expected at Jupiter in association with energetic electrons, analogous to the case at Earth. Upper limit energies for trapped protons at Jupiter are given. Using these values for peak proton energies, it can be deduced that it is not possible to obtain direct information about Jupiter's energetic trapped proton fluxes from radio noise observations at Earth. A test for energetic protons is applied to a recently developed trapped proton model. Limits to trapped proton fluxes based on the model are presented. (auth)

54007 D/H RATIO IN JUPITER'S ATMOSPHERE. Reeves, H. (CEN de Saclay, Gif-sur-Yvette, France); Bottinga, Y. Nature (London); 238: No. 5363, 326-7(11 Aug 1972).

Deuterium has recently been detected in the methane component of the Jovian atmosphere, and theoretical estimation of the D/H ratio is made with the help of recent work by Geiss and Reeves, (Astron. Astrophys. 18: 127 (1972)). (auth)

54008 ELECTRON-IMPACT EXCITATION CROSS SECTIONS AND ENERGY DEGRADATION IN CO. Sawada, T.; Sellin, D. L.; Green, A. E. S. (Univ. of Florida, Gainesville). J. Geophys. Res.; 77: No. 25, 4819-28(1 Sep 1972).

A comprehensive set of electron-impact cross sections was determined for carbon monoxide mainly on the basis of recently accumulated data on electron impact spectra, the Born approximation at high energies, and simple rules developed earlier to take into account low-energy effects. The calculation of the complete energy degradation of electrons incident on CO is carried out with these input cross sections, and the efficiencies associated with possible loss channels are presented. (41 references) (auth)

54009 ELECTRON ENERGY DEPOSITION IN CO_2. Sawada, T.; Strickland, D. J.; Green, A. E. S. (Univ. of Florida, Gainesville). J. Geophys. Res.; 77: No. 25, 4812-18(1 Sep 1972).

Semi-empirical cross sections of Strickland and Green (1969) are compared with and supplemented by more recent data. The composite set is used in the energy degradation calculation of electrons with emphasis on energies below 100 eV. Good agreements are obtained with accepted values of the loss function and the average electron volts per ion pair at high energies. Efficiencies associated with various loss channels are obtained. The relationship with the recent Mariner uv data is discussed. (25 references) (auth)

PHYSICS (ATMOSPHERIC)

Refer also to abstract 54870.

54010 52nd ANNUAL MEETING OF THE AMERICAN GEOPHYSICAL UNION, WASHINGTON, D. C., APRIL 12–16, 1971. EOS, Trans. Amer. Geophys. Union; 52: No. 4, 122–392(Apr 1971). (CONF–710408–(Absts.)).

Abstracts of ~1070 papers given at the meeting are presented. Sessions were devoted to geodesy; geomagnetism and paleomagnetism; hydrology; meteorology; oceanography; planetology; seismology; aeronomy, cosmic rays, magnetospheric physics, and solar and interplanetary physics; tectonophysics; volcanology; geochemistry; and petrology. An article on environmental crises is presented and news from the U. S. National Committee for the International Hydrological Decade is included. (J.C.W.)

Auroral and Ionospheric Phenomena

Refer also to abstract 54056.

54011 (ONERA–Publ.–137) FLOW OF A COLLISIONLESS PLASMA AROUND A CYLINDER IN VIEW OF APPLICATIONS TO IONOSPHERIC PROBES. Fournier, Gerard (Office National d'Etudes et de Recherches Aerospatiales, Chatillon-sous-Bagneux (France)). 1971. 81p. (In French). Dep. NTIS (U. S. Sales Only).

An iterative numerical method (analogue network, computerized treatment of trajectories) is proposed for the steady-state case in the absence of a magnetic field. There are considerably less constraints on the choice of parameters in this method than in those previously used. A very important aspect is the possibility of removing the Maxwell–Boltzmann equilibrium distribution restriction for the electrons. In this way, it is demonstrated that, at potentials slightly in excess of the plasma potential, the sheath structure no longer exists. In the wake, special phenomena take place that involve a potential sink, and a two-beam structure. The probe currents are examined. The complete characteristics are established, together with the evolution of the electrostatic drag. These results are compared with experimental results obtained in the ionosphere, and in simulation experiments. The investigation demonstrates that the ion current decreases between the plasma potential and the beam stagnation potential. It also demonstrates that probes in hypersonic flight, whose diameters are too long (with respect to the Debye length) cannot be used to measure the electron temperature. (France)

54012 (SC–RR–720543) ROCKET-BORNE AURORAL OPTICAL MEASUREMENTS. Tisone, G. C.; Woods, R. O.; Hoffman, J. M. (Sandia Labs., Albuquerque, N. Mex.). Aug 1972. 62p. Dep. NTIS.

The optical results from rocket-borne auroral experiments are presented. Measurement of the Hβ intensities indicate that there was no appreciable precipitation of protons for the flight on March 19, 1971, while data for the flight on March 27, 1971, indicate that there may have been localized precipitation of protons. Data are presented for the overhead brightness and volume emission rates for N_2 (3371 A), N_2^+ (3914 A), and O (5577 A). Comparisons between observed volume emission rate for 3914 A and a calculated volume emission rate using two different forms of the differential electron spectrum have been made. The O (5577 A) data have been compared to various proposed excitation mechanisms. Because of the uncertainty in atomic oxygen densities, direct electron excitation of the $O(^1S)$ state cannot be ruled out as the main mechanism above 110 km. Comparison between the experimental data and excitation due to dissociative recombination is also discussed. An estimate of the magnitude of the cross section for excitation due to dissociative excitation has been made assuming that this is the main mechanism for excitation of the $O(^1S)$ state. (auth)

54013 AURORAL PHOTOMETRIC OBSERVATIONS AT GEOMAGNETICALLY CONJUGATE POINTS. Spitz, A. L. (Arctic Inst. of North America, Washington, D. C.); Watson, M. D. Planet. Space Sci.; 20: No. 8, 1337–43(Aug 1972).

Identical auroral photometers were operated at the conjugate pair, Great Whale River and Quebec–Byrd Station, Antarctica, during the austral winter of 1966. Using a small field centered on the geographic zenith, correlation studies of auroral intensity at 5577 Å show a decrease in the level of conjugacy with increasing planetary magnetic index, K_p. (auth)

54014 SPECTROSCOPIC STUDIES OF THE ARC OF MARCH 8–9, 1970. Hernandez, G. (National Oceanic and Atmospheric Administration, Boulder, Colo.). Planet. Space Sci.; 20: No. 8, 1309–21(Aug 1972).

Optical measurements of the emissions from $O(^1D)$, $O(^1S)$, and $N(^2D)$ states during the arc event of March 8 to 9, 1970, are reported. Neutral kinetic temperatures derived from (O I) 6300-Å emission line profiles indicate a slight, near 100°K, heating of the atmosphere within the arc region. (N I) 5200-Å radiation from within the arc with an emission rate of about 0.2 R was measured, and from this measurement an estimate of $N(^4S)$ concentration of 2.5×10^7 cm^{-3}, at 240 km, was obtained. Calculated peak height emissions as well as experimental measurements, for (O I) 6300 Å, showed the arc to be about 500 km for most of the observations decaying at the end of the observations to about 400 km. The (O I) 6300-Å height of peak emission was found to be strongly correlated with the peak electron concentration, and weakly with height of maximum electron concentration. (O I) 5577-Å emission associated with the arc was observed, in agreement with the previously proposed electron thermal-conduction mechanism, and apparently as well as with the soft-electron precipitation mechanism, for the excitation of optical emissions leading to arcs. (auth)

54015 REFRACTIVE INDEX AND ATTENUATION SURFACES IN THE VICINITY OF THE CROSS-OVER LEVEL. Jones, D. (ESTEC, Noordwijk, Netherlands). Planet. Space Sci.; 20: No. 8, 1173–84(Aug 1972).

Below the proton gyrofrequency, both polarization reversal and coupling are of paramount importance in any discussion involving ion-cyclotron whistlers and related phenomena. In the absence of collisions the critical coupling angle θ_c is zero but, when collisions are included, θ_c takes a value between zero and $\pi/2$. It is therefore of interest, particularly for ray tracing at these frequencies, to investigate the refractive index and attenuation surfaces. These are found to be deformed near the cross-over level for angles between zero and θ_c, and could possibly lead to focussing of the waves. (auth)

54016 CORRELATION BETWEEN THE ELECTRON CONCENTRATION OF E REGION WITH HEIGHT OF SUN. Alimov, O. Byull. Inst. Astrofiz., Akad. Nauk Tadzh. SSR; No. 59, 28–30(1971). (In Russian).

Results of calculations of the electron concentration of the E region N_mE in summer–winter, 1964, and a correlation between N_mE and $(\cos z)^n$ for the latitude of Duschanbe are given. It is established that the index n has a value 0.50 ± 0.02 for summer and 0.48 ± 0.03 for winter. (tr-auth)

54017 RESULTS OF INVESTIGATIONS OF E REGION OF IONOSPHERE OVER DUSHANBE IN 1964. Alimov, O. Byull. Inst. Astrofiz., Akad. Nauk Tadzh. SSR; No. 59, 31–3(1971). (In Russian).

The conditions of the E region of the ionosphere over Dushanbe in 1964 were analyzed. Results and conclusions of the experimental investigations on the E-region critical frequency are included. (tr-auth)

54018 ATMOSPHERIC-WAVE-INDUCED INSTABILITY IN THE E REGION. Beer, Thomas Ivan. London, Ont.; Univ. of Western Ontario (1971). National Library of Canada, Ottawa. Thesis.

It is shown that ionospheric E-region gradient instabilities induced by westward propagating internal atmospheric gravity waves in the presence of westward directed electric fields would explain the observed velocities and heights of nighttime sporadic E. The relationship between the thickness and horizontal extent of the low blanketing frequency sporadic E formed by this mechanism is plotted for various heights in the E region. It is also pointed out that the drift motion of the ionization due to the perpendicular electric and magnetic fields can inhibit the formation of wind-shear sporadic-E layers. The first quantitative assessment of the spatial resonance mechanism predicted by Whitehead (1971) is made, and it is shown that it is very unlikely to play any significant ionospheric role. In the course of this analysis, a number of D-region results come to light and it is shown that in the D region all irregularities will tend to move with the ion drift velocity. (Diss. Abstr. Int., B)

54019 HISTORY OF THE USE OF BALLOONS IN SCIENTIFIC EXPERIMENTS. Pfotzer, G. (Max-Planck-Institut fuer Aeronomie, Lindau, Ger.). Space Sci. Rev.; 13: No. 2, 199–242(Jun 1972).

Balloons have been used for nearly 190 years in scientific

experiments and the first astronauts went aloft on Nov. 21, 1783, maintaining a straw fire to ascend or descend at will. After a discussion of the early hot-air balloons, the first experiment of Charles and the Robert brothers with a hydrogen-filled balloon is followed, including the history of flights with animals and man. In the early 1800's, environmental conditions, height-dependent magnetic-field variations, and other meteorological parameters were investigated. In the later half of 1800, balloon astronomy began with an observation by Sivel and Croce–Spinelli at an altitude of 6000 m. In the period from 1912 to 1932, the agent that maintains the conductivity of the air was investigated and cosmic-radiation knowledge and instrumentation were advanced. Stratospheric measurements began in 1932 and, until 1947, manned flights remained below 23,000 m with an air mass overhead of 40 g/cm^2, whereas the sounding balloons, at altitudes of more than 30,000 m with less than 10 g/cm^2 air overhead were reached. Plastics became available in 1947 suitable for the construction of big balloons with a very light-weight skin that also met the requirements to withstand stresses exerted by heavy payloads. (97 references) (J.C.W.)

54020 CONJUGATE FEATURES OF MAGNETOSPHERIC ELECTRON DYNAMICS OBSERVED AT BALLOON ALTITUDES. Barcus, J. R. (Univ. of Denver). Space Sci. Rev.; 13: No. 2, 295-312(Jun 1972).

Analysis of recent observations (from balloons, spacecraft, and surface observatories) demonstrate regional, shell, and nearpoint conjugacy at L ~ 7 during precipitative events that were characterized by local acceleration as well as release of gradient-drifted electrons injected during substorms. A number of new features of magnetospheric dynamics relating to substorm development and sudden-commencement effects, have been brought to light which, though poorly understood at present, may prove of considerable importance and are worthy of further investigation. During the initial period of instability in substorm evolution, preceding the slower magnetotail convective injection, precipitation of waves of electrons in rapid polewards motion exhibit L-shell conjugacy near midnight. Transient, large-scale expansions of the magnetospheric electron population accompanied by temporally imbedded substorms display large scale regional conjugacy and are simultaneously observed as similarly transient dropouts at balloon altitudes. Precipitation from gradient-drifting electrons in the dayside magnetosphere exhibits near-point conjugacy, at least down to the order of 50 km and quite probably less. Similarly tight conjugacy applies to the release of electrons showing a specific local response to sudden commencements. Analysis of the approach to and attainment of spectral equilibrium in the precipitation observed from drifting electrons may provide information about either, or both, the source spectrum at injection and the process of local release. The specific precipitation effect sometimes observed at the time of an sc remains a rather puzzling feature, although it seems clear now that the acceleration and/or release process responsible is of a highly local nature and works selectively at small pitch angles well within the magnetospheric boundary. Coupling of the interplanetary shock with the magnetosphere must be an important aspect, but the details are not clear as yet. On at least one occasion, a large part (perhaps all) of the magnetospheric electron population varied in a nearly synchronous manner in response to solar-wind-induced distortions during the variable compressive phase of a sudden-commencement geomagnetic storm. In the ongoing effort to identify and understand acceleration and release mechanisms involved in magnetospheric dynamics, balloon-borne experiments will continue to be useful, providing essential information presently unattainable by other means. (auth)

54021 POLARIZATION PROPERTIES OF Pc 1 MICROPULSATIONS AT LOW LATITUDES. Summers, W. R. (Univ. of Newcastle, Australia); Fraser, B. J. Planet. Space Sci.; 20: No. 8, 1323-35(Aug 1972).

Polarization studies of hydromagnetic-emission-type Pc-1 micropulsation events in the plane of the Earth's surface were undertaken using a three station network in South–East Australia. Using selected data over a three-year period, a consistent polarization pattern was observed from the three stations. This is discussed in terms of temporal variations in the ellipse major axis direction, ellipticity, and direction of rotation of the perturbation vector. Interpretation of these results in terms of ionospheric waveguide propagation is also considered. (auth)

54022 ELECTRON ENERGY TRANSFER RATES IN THE IONOSPHERE. Stubbe, P.; Varnum, W. S. (Max-Planck-Institut fuer Aeronomie, Lindau, Ger.). Planet. Space Sci.; 20: No. 8, 1121-6(Aug 1972).

In upper-atmospheric physics the energy transfer rates from electron to neutral gases, especially through inelastic collisions, are important and frequently needed quantities. The rates for vibrational excitation of O_2 and N_2 and for electronic excitation of O to the ^1D state were calculated and fitted to analytic expressions as an aid to the researcher and a necessity for atmospheric and ionospheric modeling by computer. The other important transfer rates were summarized for quick reference. (auth)

54023 POSITIVE GEOMAGNETIC BAYS IN EVENING HIGH LATITUDES AND THEIR POSSIBLE CONNECTION WITH PARTIAL RING CURRENT. Kamide, Yohsuke; Fukushima, Naoshi (Tokyo Univ.). Rep. Ionosphere Space Res. Jap.; 26: No. 1-2, 79-101(1972).

Space-time characteristics of polar magnetic substorms in the evening hours are investigated with the aid of a dense network of geomagnetic observatories in Europe. The positive bays in the evening high latitudes are not necessarily always the return current of an intense westward electrojet extended along the auroral oval, although it is true that a strongly concentrated eastward electrojet does often appear at the maximum phase of substorm. The H increase from the pre-bay level at conjugate stations shows approximately the same magnitude. The features of the eastward electrojet are: (1) the current center is situated at the auroral zone (not on the auroral oval), and it shifts equatorward during the developing stage of substorm, (2) the positive bay region drifts westward, and (3) the appearance of eastward electrojet is accompanied by an enhancement in the partial ring current, proton aurora, and CNA. Since the growth and decay of the eastward electrojet is so closely connected with those of a partial ring current in the magnetosphere centering the evening region, it is conjectured that the positive bay in high latitudes appears when the ionospheric conductivity is increased by the impinging protons from the partial ring current in the magnetosphere. The positive bay in high latitudes is revealed by the concentration along the auroral-zone ionosphere of electric currents, which are connected with field-aligned currents from the partial ring current. (auth)

54024 PHOTOCHEMISTRY OF THE AIRGLOW CONTINUUM. Sternberg, J. R. (Oxford Univ.). Mon. Notic. Roy. Astron. Soc.; 159: No. 1, 21-9(1972).

Recent observations of the airglow continuum and related phenomena are discussed in an effort to identify the photochemical processes responsible for the emission. After an exhaustive examination it is suggested that most of the continuum is due to collision-induced transitions of the O_2 molecule from bound states close to the dissociation limit,

$$O_2^*(^1\Sigma_g^+) \rightarrow O_2^*(^3\Sigma_g^-) + h\nu \text{ (5000 to 9000 Å)}$$

$$O_2^*(^1\Delta_g) \rightarrow O_2^*(^3\Sigma_g^-) + h\nu \text{ (7000 Å to 2.2 } \mu\text{)}$$

with estimated emission rates of 1 and 150 kR, respectively. Present ideas about the mechanism of recombination of atoms cannot explain the existence of this emission and need revising. There is also a continuum from the reaction $NO + O \rightarrow NO_2 + h\nu$ (4000 to 5500 Å) with an emission rate of about 200 R that can vary independently from that of the O_2 continuum. (auth)

54025 OBSERVATIONS OF THE AIRGLOW CONTINUUM. Sternberg, J. R.; Ingham, M. F. (Oxford Univ.). Mon. Notic. Roy. Astron. Soc.; 159: No. 1, 1-20(1972).

A program of observations of the night-sky continuum over the range 4100 to 8200 Å is described. In reducing the results careful consideration was given to the brightness and spectral distribution of the zodiacal light and integrated starlight, which are then subtracted from the total continuum to obtain the airglow. As well as confirming the existence of an airglow continuum, the results show evidence of discrete structure at certain wavelengths and a large increase in brightness in the near infrared. A preliminary study of the temporal variations of the continuum was also made. (auth)

54026 ION ADMIXTURE DISTRIBUTION IN THE IONOSPHERIC F REGION. Zhmur, L. E. (Gorky State Univ., USSR). Izv. Vyssh. Ucheb. Zaved., Radiofiz.; 15: No. 4, 490-6(1972). (In Russian).

A one-dimensional nonisothermal diffusion in the ionospheric F region is considered for the stationary case. The analysis is made for two sorts of positive ions taking into account the ionization and recombination, as well as the influence of the force of gravity. A system of two related equations was obtained for electron and ion densities. A reduction is made to the case of admixture ions, determining the dissociative recombination. The criteria are given for this case. When they are satisfied, the distribution found coincides with that obtained by Mange without allowance for photochemical processes. (tr-auth)

54027 THEORY OF INSTABILITY IN THE IONOSPHERIC CURRENT JET. Kotik, D. S. (Gorky State Univ., USSR). Izv. Vyssh. Ucheb. Zaved., Radiofiz.; 15: No. 4, 497-503 (1972). (In Russian).

The generation of potential waves by a transverse current in

the ionospheric electrojet region is considered. A numerical method is used to solve the dispersion equation for the cases of weak current and small increments. The region of the lower hybrid resonance is analytically investigated. The dispersion curves and the dependence of the increments on the wave number and the ionospheric plasma parameters have been found. (tr-auth)

54028 SIMULTANEOUS MEASUREMENTS OF THE ELECTRON DENSITY AND THE COLLISION FREQUENCY IN IONOSPHERIC D REGION BY THE METHOD OF PARTIAL REFLECTION. Benediktov, E. A.; Grishkevich, L. V.; Ivanov, V. A. Izv. Vyssh. Ucheb. Zaved., Radiofiz.; 15: No. 5, 694-702(1972). (In Russian).

The electron density N in the ionospheric D region may be found by the correlation coefficient of amplitudes of ordinary and extraordinary radio-wave components backscattered by D-region inhomogeneities. Using the simultaneous measurement of the difference in the normal-wave differential absorption, the number of electron collisions with the neutral molecules ν_m may be found. A method of estimating N and ν_m is described. The preliminary measurement results of ν_m during two sudden ionospheric disturbances at the frequency 5.75 MHz are given. (tr-auth)

54029 POWER-LAW WAVENUMBER SPECTRUM DEDUCED FROM IONOSPHERIC SCINTILLATION OBSERVATIONS. Rufenach, Clifford L. (National Oceanic and Atmospheric Administration, Boulder, Colo.). J. Geophys. Res.; 77: No. 25, 4761-72 (1 Sep 1972).

Ionospheric scintillation observations near Boulder, Colorado, from the radio source Cygnus A were spectral analyzed at 26 MHz. The scintillation spectral features are used to calculate the diffraction effects and hence deduce the F-region irregularity wavenumber spectrum for sizes from about 4 to 0.6 km. The wavenumber spectrum on many occasions follows a power-law variation $P_N(\kappa_x) \propto \kappa_x^{-\beta_H+1}$, where β_H typically varies from 3 to 4. An example based on the Gaussian spectrum shows that the extrapolation to radio frequencies much higher than 26 MHz will not explain the observed equatorial and auroral scintillations. Abrupt changes in electron density are required to support the higher-wavenumber spectral densities that cause these higher-frequency scintillations. These abrupt density changes can be represented by a power-law wavenumber spectrum. The scintillation-deduced power-law variation agrees with in-situ density spectra measurements from the Ogo-6 satellite. Several production mechanisms that follow a power-law variation are discussed. The measurement of the wavenumber spectrum will help explain the mechanism that produces small-scale irregularities. (40 references) (auth)

54030 EXTREME-ULTRAVIOLET EMISSIONS FROM AN AURORA. Paresce, Francesco; Lampton, Michael; Holberg, Jay (Univ. of California, Berkeley). J. Geophys. Res.; 77: No. 25, 4773-81(1 Sep 1972).

Two ultraviolet photometers were flown on a Javelin sounding rocket launched from Fort Churchill, Canada, on February 18, 1970, into a weak auroral breakup. The photometers covered the wavelength bands 300 to 1000 A and 1050 to 1500 A and observed the aurora while the rocket was above the emitting regions. The observed radiations were found to originate from the visible and x-ray auroral forms recorded by ground-based all-sky cameras and on-board gas proportional x-ray counters. The intensities in the 1050- to 1500-A band were compatible with previous experimental data and available theoretical intensity calculations. The determination of the emitted intensities in the 300- to 1000-A band was hampered by the uncertainties about the wavelength of the radiations being observed, but, if electron excitation of the molecular nitrogen bands at approximately 900 A is assumed to be the dominant mechanism, intensities of up to 150 kR were recorded. Alternate mechanisms considered involved an additional source of radiation in the 650- to 750-A range. In this case, the observed signals corresponded to approximately 20 to 40 kR of 900-A radiation. Evidence that, on one occasion, radiation from an auroral feature exhibited a temporal pulsation at a frequency of ≈10 Hz is presented. This event was correlated with a simultaneous hardening of the particle energy spectrum. (auth)

54031 THEORETICAL CALCULATIONS OF THE F-REGION TROPICAL ULTRAVIOLET AIRGLOW INTENSITY. Anderson, D. N. (Univ. of Colorado, Boulder). J. Geophys. Res.; 77: No. 25 4782-9(1 Sep 1972).

Far ultraviolet airglow emissions at 1304 and 1356 A from atomic oxygen have been observed to exist in two bands or arcs 12 to 15° north and south of the magnetic equator, the height-integrated intensity of the emissions maximizing between 2100 and 2200 LT during equinox. Two of the mechanisms thought to be responsible for producing the excited states of atomic oxygen are neutralization ($O^+ + O^- \rightarrow O^* + O$) and radiative recombination ($O^+ + e \rightarrow O^* + h\nu$). To investigate the contribution made by each process, the daily variation of the column emission rate from 20°N to 20°S dip latitude in the ionospheric F region is theoretically calculated by numerically solving the time-dependent electron continuity equation, taking into account the effects of production, loss, ambipolar diffusion, vertical E × B drift, and neutral winds. The geomagnetic field is approximated by a centered, tilted dipole, and the effects of east-west drift have been neglected. Since the electron density's latitudinal distribution is strongly dependent on vertical E × B drift, the generated airglow intensity is also drift dependent, but in a different way for each generating mechanism. Results are presented, and the differences are investigated for two electric-field models assuming solar-cycle maximum and minimum. Of the two mechanisms, radiative recombination produces results that are in better agreement with the observations, although the calculated emission rates are still lower than the observed values. (28 references) (auth)

54032 D-REGION MEASUREMENTS WITH THE DIFFERENTIAL-ABSORPTION, DIFFERENTIAL-PHASE PARTIAL-REFLECTION EXPERIMENTS. Belrose, J. S. (Communications Research Centre, Ottawa); Burke, M. J.; Coyne, T. N. R.; Reed, J. E. J. Geophys. Res.; 77: No. 25, 4829-38(1 Sep 1972).

Measurements of the differential phase of partial reflections over a limited height range (60 to 75 km) have been made simultaneously with the differential amplitude measurements normally made at Ottawa (45°N, 76°W) on a frequency of 2.66 MHz. The addition of the differential-phase data provides a means of measuring the collision frequency in the lower D region that is independent of differential-amplitude measurements in the region where differential absorption is negligible. The two types of measurement have been found to be in satisfactory agreement. Furthermore, the simultaneous measurement of differential phase and amplitude provides a means of investigating the nature of the irregularities causing the partial reflections. It is concluded that these are predominantly irregularities in the electron density in the region. (auth)

54033 ELECTRON DEPOSITION IN WATER VAPOR, WITH ATMOSPHERIC APPLICATIONS. Olivero, J. J.; Stagat, R. W.; Green, A. E. S. (Univ. of Florida, Gainesville). (Contract AT(40-1)-3798. J. Geophys. Res.; 77: No. 25, 4797-4811(1 Sep 1972).

The consequences of electron impact on water vapor in terms of the microscopic details of excitation, dissociation, and ionization and combinations of these processes were examined. Basic electron-impact cross-section data are assembled in many forms and are incorporated into semi-analytic functions suitable for analysis with digital computers. Energy deposition in water vapor is discussed and the energy-loss function is presented, along with the "electron volts per ion pair" and the efficiencies of energy loss in various processes. Several applications of electron and water-vapor interactions in the atmospheric sciences such as H_2O comets, aurora and airglow, and lightning are considered. In general it is found that, except in the case of lightning, other processes are more likely sources of H^*, O^*, and OH^* emissions. (47 references) (auth)

54034 OCCURRENCE OF Pc 4, 5 MICROPULSATION ACTIVITY AT THE POLAR CUSP. Rostoker, Gordon; Samson, John C.; Higuchi, Y. (Univ. of Alberta, Edmonton). J. Geophys. Res.; 77: No. 25, 4700-6(1 Sep 1972).

Data from a line of magnetometers stretching along a corrected geomagnetic meridian ~302°E through western Canada are used to study the latitude-dependent characteristics of Pc-4 and Pc-5 micropulsation activity. Though most of this activity follows a well-defined frequency-latitude dependence, a broadband class of Pc-4 and Pc-5 activity is found to occur at very high latitudes ($\Lambda > 75°$) during the daytime hours. It is suggested that this high-latitude magnetic activity is generated in the daytime polar cusp and that the observation of this activity from ground-based stations can be used to determine the latitude of the dayside polar cusp. Three possible mechanisms for the generation of the Pc-4 and Pc-5 activity in the polar cusp are the Alfvén-wave instability, the drift-wave instability, and the Kelvin-Helmholtz instability. (46 references) (auth)

54035 INVESTIGATION OF INTERACTION BETWEEN Pc 1 AND 2 AND Pc 5 MICROPULSATIONS AT THE SYNCHRONOUS ORBIT DURING MAGNETIC STORMS. Barfield, J. N.; McPherron, R. L. (Univ. of California, Los Angeles). J. Geophys. Res.; 77: No. 25, 4707-19(1 Sep 1972).

Coincident Pc-5 and Pc-1 and Pc-2 micropulsations were observed at the synchronous equatorial satellite ATS 1 during the main phase of 11 geomagnetic storms that occurred in 1967. The Pc-1 and Pc-2 oscillations were quasi sinusoidal, with periods of 5 to 20 sec and amplitudes of 1 to 2 γ. Their average polarization was transverse to the ambient magnetic field. The oscillations

were elliptical and rotation was to the left in relation to the main field. The observed characteristics suggest that the Pc-1 and Pc-2 activity was due to ion-cyclotron resonance of Alfvén waves with energetic protons. It is shown that, in the afternoon sector of the ATS 1 orbit, several mechanisms exist that could cause the ion-cyclotron resonance to occur with particles of ring-current energy, producing waves of the observed frequency. (22 references) (auth)

54036 STATISTICAL CHARACTERISTICS OF STORM-ASSOCIATED Pc 5 MICROPULSATIONS OBSERVED AT THE SYNCHRONOUS EQUATORIAL ORBIT. Barfield, J. N.; McPherron, R. L. (Univ. of California, Los Angeles). J. Geophys. Res.; 77: No. 25, 4720-33(1 Sep 1972).

The results of a statistical study of storm-associated Pc-5 magnetic oscillations observed at the synchronous equatorial satellite ATS 1 during 1967 are presented. The observed oscillations had a mean frequency of 0.005 Hz and a mean amplitude of 10 γ; the typical event lasted approximately one hour. The oscillations were highly elliptical, with a mean ellipticity of <0.1, and the preferred direction of the major axis of polarization lay within 19° of the geomagnetic meridian plane. Dynamic spectral analysis showed that the wave events were quite stable in the spectral characteristics; that is, the auto spectra, ellipticity, orientation, et cetera, did not change significantly during the course of the individual events. Examination of the occurrence distribution clearly showed that the observed Pc-5 oscillations were associated with the main-phase minimum and were confined to the afternoon sector. A study of ground magnetograms for the times of interest showed that for 85% of the events the onset of the waves was clearly correlated with the expansion phase of magnetospheric substorms. The results of this study strongly support the earlier suggestion (Barfield, et al., 1972) that the storm-time oscillations are generated by an instability of the enhanced storm-time partial ring current and its associated hot ($\beta \geq 1$) plasma. 39 references. (auth)

54037 SPATIAL AND TEMPORAL VARIATIONS OF THE THERMAL PLASMA BETWEEN 3000 AND 5700 KILOMETERS AT L = 2 TO 4. Bewersdorff, A. B. (Regis Coll., Weston, Mass.); Sagalyn, R. C. J. Geophys. Res.; 77: No. 25, 4734-45(1 Sep 1972).

The spatial and temporal variations of the thermal plasma between L = 2 and L = 4 over the altitude range 3000 to 5700 km have been studied. The data were obtained from two spherical electrostatic analyzers flown on the polar orbiting satellite OV 3-1 between April 1966 and February 1967. During magnetically quiet periods the ionization density is characteristically found to decrease monotonically with increasing L. Between L = 2 and L = 3 a dependence of the average electron density on longitude is found, with the maximum between April and August occurring at 150°E and the minimum at 300°E. At L < 4, major charge-density irregularities are found on 30% of the orbits at times of quiet to moderate magnetic activity, sometimes consisting of over an order of magnitude changes in density in less than 0.1 L. Comparison of density profiles obtained on the same day at different longitudes shows the irregularities to be of limited longitudinal extent. It is suggested that the depletions result from inward shifts of sectors of the plasmapause to lower L shells by E × B drifts. Large-amplitude, small-scale irregularities extending over tens of kilometers are often superimposed on the major density gradients and appear to be the result of plasma instabilities. 24 references. (auth)

54038 VHF POWER SPECTRA OF THE RADAR AURORA. Balsley, B. B. (National Oceanic and Atmospheric Administration, Boulder, Colo.); Ecklund, W. L. J. Geophys. Res.; 77: No. 25, 4746-60(1 Sep 1972).

Power spectra of vhf radar auroral echoes were obtained near Anchorage, Alaska, during October 15–23, 1970. These spectra were obtained concurrently with standard range-time-intensity (RTI) film strips of the echoing region using the same radar system. In this paper, these spectra and the RTI film strips are examined and are compared with previously defined radar auroral classifications. The results indicate that there are at least two, and possibly three, separate types of spectra that correspond to identifiable echo configurations on the RTI film strips. Identification of the two-stream instability as an irregularity-producing mechanism for one of these spectral types is possible but not definitive. Another type of spectrum is similar to the type-II spectra seen in the equatorial electrojet. The third spectral type bears no similarity to any results obtained at the equator. (34 references) (auth)

54039 POSSIBLE CONNECTION BETWEEN A BARIUM CLOUD AND ELECTRON INTENSITY FLUCTUATIONS OBSERVED ON A ROCKET FLIGHT AT KIRUNA. Koehn, D.; Page, D. E. (European Space Research and Tech. Centre, Noordwijk, Netherlands). J. Geophys. Res.; 77: No. 25, 4888-90(1 Sep 1972).

A Skylark rocket was launched from Kiruna on Feb. 14, 1970 when a moderate magnetic disturbance was in progress and an auroral E layer of a few megahertz could be observed. The payload contained an electric double-probe experiment, a Langmuir probe, a plasma-wake detector, and a barium-cloud experiment for measurement of electric fields in the auroral ionosphere. A simple Geiger counter system was aboard to determine the integrated electron precipitation at energies above 15 keV. Details of the Geiger counter experiment are given. The rocket reached an apogee of 208 km, and the mean electron intensity was of the order of 5×10^3 el/cm^2 sec ster for a height above 150 km. A sudden increase by a factor of 2 started at 167 sec flight time and a less significant enhancement started at 230 sec flight time. Both events occurred immediately after the release of the barium clouds of the rocket payload. Other phenomena occurred in relation to the other payloads and the barium-cloud releases. An investigation continues dealing with the observations. (J.C.W.)

54040 AVERAGE BEHAVIOR OF MIDLATITUDE F-REGION PARAMETERS N_T/N_{max} AND τ DURING GEOMAGNETIC STORMS. Mendillo, Michael (Boston Univ.); Papagiannis, Michael D.; Klobuchar, John A. J. Geophys. Res.; 77: No. 25, 4891-5(1 Sep 1972).

A general description of the average F-region behavior during geomagnetic storms is summarized from data on twenty-eight storms observed from Dec. 1, 1967 to Nov. 8, 1969. The ionospheric total electron content N_T data were examined from a midlatitude station and average patterns were presented for disturbances measured from the monthly median behavior. The parameters peak density N_{max} and slab thickness $\tau \equiv N_T/N_{max}$ were examined during the same storms and average patterns were determined. The study attacks the question, "In what way does geomagnetic activity contribute to the spread in the monthly distribution of F-region parameters at midlatitudes?" (J.C.W.)

54041 COMMENTS ON LUNAR VARIATIONS IN THE PERUVIAN ELECTROJET. Geller, Marvin A. (Univ. of Illinois, Urbana). J. Geophys. Res.; 77: No. 25, 4896-8(1 Sep 1972).

An analysis was made of L_2(H), the lunar semidiurnal variation in the horizontal geomagnetic field at Huancayo, and L_2(v), the lunar daily variation in the E-region electron drift at Jicamarca by Tarpley and Balsley (J. Geophys. Res., 77: 1951(1972)). Two of the conclusions drawn by Tarpley and Balsley are discussed. A concluding fact by Tarpley and Balsley states, "there is a pronounced seasonal variation in both L_2(H) and L_2(v), the maximums and minimums occurring in January–February and July–August, respectively. The cause of this variation is unknown." Geller states the variation should more properly be called annual, and he presents a strong case to explain this annual variation in the phase and magnitude of L_2(H) and L_2(v) in a consistent manner. Another concluding fact of Tarpley and Balsley states, "L_2(v) is stronger in the daytime by at least 50%. A solar time modulation of the lunar atmospheric tide provides the simplest explanation of this effect." Geller suggests that this is not a likely explanation for the day-night variation in L_2(v) and explains that a more likely explanation could come from the nighttime decrease in the ratio $(\sigma_2 \cos I)/(\sigma_0 \sin^2 I + \sigma_1 \cos^2 I)$ from work by Tarpley and Balsley, 1972, but that possibly no variation in magnitude of the Sq drift velocity exists. Geller suggests that solar modulation of lunar effects might be easier to explain than solar modulation of solar effects. (J.C.W.)

54042 ALTITUDE DISTRIBUTION OF THE $O_2(^1\Delta)$ NIGHTGLOW EMISSION. Evans, W. F. J. (Univ. of Saskatchewan, Saskatoon); Llewellyn, E. J.; Jones, A. Vallance. J. Geophys. Res.; 77: No. 25, 4899-4901(1 Sep 1972).

Measurements were made of the 1.27-μ emission during the day and twilight, and the altitude distributions of $O_2(^1\Delta)$ were reported. On Feb. 8, 1972, a Black Brant 3A rocket was launched from Fort Churchill to an apogee of 122 km to measure emission in the 1.3-, 1.6-, and 1.8-μ spectral regions in addition to the 1.27-μ spectral region. This is the first report of the nightglow profile of the altitude distribution made 11 hours after sunset. Integrated intensity distributions were differentiated to obtain the volume emission rate as a function of altitude on upleg and downleg measurements. Mechanisms most likely for the production of $O_2(^1\Delta)$ and rate constants required to coincide with other data are discussed. (J.C.W.)

54043 POLAR AURORAS. Faelthammar, Carl-Gunne (Kungliga Tekniska Hoegskolan, Stockholm). Recherche (Paris); 3: No. 24, 537-45(Jun 1972). (In French).

The extremely varied aspects presented by the polar auroras are described. The parts played by the magnetosphere and the solar wind in their creation are discussed. The phenomena intervening are not very well understood; the study of the primary particles responsible for the auroras has applications in plasma physics. (France)

Effects of Nuclear Detonations

54044 (NASA-TM-X-2440, pp 178-92) ARTIFICIAL PERTURBATIONS OF THE RADIATION BELTS. Cladis, John B. (Lockheed Palo Alto Research Lab., Palo Alto, Calif.). Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

A review is given of the properties of the radiation belts produced by high-altitude nuclear detonations. The low-yield, Argus devices, 1, 2, and 3, and the Soviet test of 1 November 1962 injected intense electron fluxes in narrow L-shell intervals, with peaks at L = 1.72, 2.11, 2.17, and 1.77, respectively. The energy spectra of the electrons were indistinguishable from the equilibrium fission beta spectrum, and the fluxes initially decayed at rates approximately proportional to $(\text{time})^{-1.1}$. Across L shells the electrons diffused very slowly (Δ[full width of peak at half maximum]$^2/\Delta$[time] $\approx 10^{-4}$ [earth radii]^2/day) The high-yield devices, Starfish and the Soviet tests of 22 October and 28 October 1962, injected electrons over wide ranges of L—extending from L values near the burst locations (L $\approx$ 1.14 for Starfish, L $\approx$ 1.8 for the Soviet tests) to L $\approx$ 6. At L values near the lower boundary, the electron spectra were similar to the equilibrium fission beta spectrum; but the spectra appeared to be softer at the higher L values. The decay rates at L $\lesssim$ 1.25 were in agreement with predictions based on atmospheric scattering theory; but at L > 1.25 the decay rates were higher, indicating the predominance of electromagnetic interactions. In addition to injecting energetic electrons a high-altitude detonation may also cause previously trapped particles to be redistributed. Evidence for the occurrence of such a redistribution is presented and mechanisms which may have caused the redistribution are discussed. 33 references, 12 figures. (auth)

Particle Kinetics and Trapping

Refer also to abstracts 54023, 54868, and 54952.

54045 (NASA-TM-X-2440, pp 530-8) LOW-ENERGY PARTICLE RADIATION ENVIRONMENT AT SYNCHRONOUS ALTITUDE. Shelley, E. G.; Lew, S. K. (Lockheed Palo Alto Research Lab., Palo Alto, Calif.). Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

Low-energy charged particles in the space environment are known to be important contributors to the degradation of thermal control surfaces on satellites and may affect thin films such as cover materials used in connection with large flexible solar arrays. These particle-induced degradation effects are of particular importance in planned future satellite projects with projected lifetimes up to ten years. Early measurements in the vicinity of synchronous altitude showed that intense and highly variable fluxes of protons and electrons with energies between one and 50 keV populate this region of space. The ATS-5 satellite, launched into synchronous orbit in August 1969, was the first synchronous satellite to include instrumentation for the investigation of the plasma properties of these low-energy charged particles. The Lockheed Palo Alto Research experiment on ATS-5 measured electron and proton fluxes in the energy range from approximately one-half to several hundred keV with primary emphasis on the region below 50 keV which contains most of the plasma energy. A statistical analysis of the data, sampled over the period from September 1969 through December 1969, shows systematic variations in the average low-energy particle radiation environment at synchronous altitude with local time and magnetic activity (K_p). The existence of a systematic variation with K_p suggests the possibility of estimating the environment under various conditions of magnetic activity from the present data. 16 figures. (auth)

54046 (NASA-TM-X-2440, pp 539-47) NATURAL VARIATIONS IN THE GEOMAGNETICALLY TRAPPED ELECTRON POPULATION. Vampola, A. L. (Aerospace Corp., El Segundo, Calif.). Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

Temporal variations in the trapped natural-electron flux intensities and energy spectra are discussed and demonstrated using recent satellite data. These data are intended to acquaint the space systems engineer with the types of natural variations that may be encountered during a mission and to augment the models of the electron environment currently being used in space system design and orbit selection (Vette et al.) For systems or subsystems that are particularly sensitive to radiation and that respond to changes in the environment on a short time scale, these models by themselves may be inadequate for proper subsystem design or interpretation of on-orbit data. Some of the temporal variations demonstrated, which are not widely known, include: addition of very energetic electrons (E $\geq$ 5 MeV) to the outer zone during moderate magnetic storms; addition of energetic electrons (E > 1 MeV) to the inner zone during major magnetic storms; inversions in the outer-zone electron energy spectrum during the decay phase of a storm injection event; and occasional formation of multiple maxima ($\geq$4) in the flux vs altitude profile of moderately energetic electrons (E $\leq$ 1 MeV). 14 figures. (auth)

54047 (NASA-TM-X-2440, pp 548-55) TRAPPING OF TRANSURANIUM ELEMENTS BY THE EARTH'S MAGNETIC FIELD. Bloom, Justin L.; Eastlund, Bernard J. (Atomic Energy Commission, Washington, D. C.). Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

The search for a transuranium element component of cosmic radiation has been carried out in high-altitude balloon experiments by Price, Fleischer, Walker, and Fowler. It is shown that the trapping of high-Z elements on orbits in the Earth's magnetic field may lead to a sufficient enhancement of the intensity of particle flux to make it possible to detect these elements by satellite experiments. Calculations are presented that predict the behavior of trapped particles as a function of the predicted flux and energy distribution of high-Z elements incident on the Earth's magnetic field. Techniques are suggested for the detection of such particles. In addition, the possibility of production of transuranium elements in the recently discovered pulsars is discussed. (auth)

54048 (NASA-TM-X-2440, pp 561-8) SUMMARY OF THE OV1-19 SATELLITE DOSE, DEPTH DOSE, AND LINEAR ENERGY TRANSFER SPECTRAL MEASUREMENTS. Cervini, John T. Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

Measurements were made in the inner Van Allen radiation belt by tissue-equivalent ionization chambers (TEICs) and cellular absorbed dose linear energy transfer spectrometer on the OV1-19 satellite. Results of data reduction are presented for the solar flare events in April, Nov., and Dec. 1969. The TEIC data show that a considerable dose rate can be expected even behind shielding whose cutoff energy is $\geq$70 MeV. Protons of high energy (>60 MeV) are the dominant hazard to man in space. The geomagnetic field screens out the solar flare protons in the nonpolar regions, but not if the flare rigidity is great enough. 14 figures. (D.L.C.)

54049 (NASA-TM-X-2440, pp 748-55) RADIATION PROBLEMS ASSOCIATED WITH SKYLAB. Braly, John E.; Heaton, Thomas R. (Martin Marietta Corp., Baltimore). Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

Skylab, an experimental space station, will orbit the earth during 1972-73. Sixty experiments will be carried out during its flight, 26 of which use some type of photographic film. In its circular orbit of 235 n mi, inclined 50°, it passes through the Van Allen belt several times a day. Radiation tests were conducted on the various types of Skylab film to establish the total radiation dosages compatible with an acceptable level of film fogging, and on the S190 borosilicate window to establish radiation limits for an acceptable darkening level. The results verified that most of the films would be unusable when returned to earth, and that the borosilicate window would be darkened beyond allowable limit, unless additional protection was provided. The operational solutions to these problems involve protecting the film with five film vaults and protecting the window with a radiation shield. The largest vault is made of aluminum and weighs over 2000 lb (its thickest compartment wall is 3.4 in.). The window radiation shield is a light honeycomb structure which is swung away for limited astronaut viewing or when the S190 experiment is in operation. Although the shield is lightweight, it is heavy enough to stop the large number of low-energy electrons making up a major part of the external environment and which are potentially damaging to the window. The paper contains a brief description of the Skylab mission and some of the associated experiments. The radiation environment which the spacecraft will encounter is discussed. The results of the radiation test programs on Skylab photographic film and on borosilicate glass are presented. Operational solutions to the two problems of excessive film fog and loss of transmittance through the glass are described. (auth)

54050 NONLINEAR THEORY OF MONOCHROMATIC CIRCULARLY POLARIZED VLF AND ULF WAVES IN THE MAGNETOSPHERE. Bud'ko, N. I. (Inst. of Terrestrial Magnetism, Ionosphere and Radio-wave Propagation, Moscow); Karpman, V. I.;

Pokhotelov, O. A. Cosmic Electrodyn.; 3: No. 2, 147-64(Jul 1972).

The interaction of resonant particles with a monochromatic circularly polarized wave propagating along the magnetic field in a homogeneous plasma is investigated. It is shown that the damping (or growth) rate of the wave vanishes after a time of order of the characteristic oscillation period of resonant particles. Propagation of monochromatic waves in an unstable plasma is accompanied by the generation of two side bands, which have frequency shifts relatively to the main wave of the order of the oscillation frequency of resonant particles. Theoretical results are compared with known experimental data concerning monochromatic vlf (monochromatic whistler) and ulf (Pc-1 micropulsation waves). (auth)

54051 PHYSICAL MECHANISM OF THE MAGNETOSPHERIC SUBSTORM DEVELOPMENT. Kropotkin, A. P. (Moscow State Univ.). Planet. Space Sci.; 20: No. 8, 1245-57(Aug 1972).

A phenomenological model of the plasma flow at the inner edge of the magnetotail plasma sheet is proposed. Convective transfer and spatial diffusion of plasma across geomagnetic-field lines together with particle precipitation into the ionosphere (caused by pitch-angle scattering) are taken into account. Two types of steady-state solutions are obtained; they represent conditions for the substorm growth and expansion phases, respectively. The earthward flow of the plasma is retarded, and a convective instability of the flow occurs at the inner boundary of the plasma sheet. This may be a cause of transformation of one-flow mode into the other. The model predicts a fast transit from the growth phase to the expansion phase. (auth)

54052 RESONANT INTERACTION OF AN ELECTROSTATIC WAVE WITH ELECTRONS IN A CURRENT SHEET. Gjoeen, Einer (Univ., Bergen). Planet. Space Sci.; 20: No. 8, 1205-12(Aug 1972).

A one-dimensional model of a current-sheet with a static electric potential is considered. Free electrons and protons move in opposite directions under the influence of the potential and a solution is sought for the potential in a bounded region in space (over the sheet width). The general solution is found to be plasma oscillations. Then, introducing a short-wavelength monochromatic wave as a perturbation, it is shown by the method of stationary phase that electrons in resonance give a growth (damping) rate similar to the Landau formula. There is the possibility, however, that the wave can both grow and damp in different regions when traversing the sheet as it will sample electrons from various parts of the zero-order distribution function. (auth)

54053 GEOMAGNETIC DISTURBANCES IN THE POLAR CAP. S_q^p AND DP-2. Kawasaki, K.; Akasofu, S.-I. (Univ. of Alaska, College). Planet. Space Sci.; 20: No. 8, 1163-72(Aug 1972).

It is shown that the daily magnetic variation in the polar cap on moderately disturbed days is essentially identical to that of extremely quiet days, but significantly enhanced. On the basis of an extensive analysis of magnetic and auroral records, it is shown that the particular type of magnetic variation identified as the DP-2 mode is not a new and distinct variation, but is one of the manifestations of magnetospheric substorms. (auth)

54054 EQUILIBRIUM POTENTIAL OF A MAGNETOSPHERIC SATELLITE IN AN ECLIPSE SITUATION. Knott, K. (ESTEC, Noordwijk, Netherlands). Planet. Space Sci.; 20: No. 8, 1137-46(Aug 1972).

The order of magnitude of the equilibrium potential of a surface exposed to the particle environment outside the magnetospheric plasmasphere is calculated. This is done under the assumption that no solar irradiation reaches the surface, thus no photoemission becomes effective. It is shown that for a given surface material the equilibrium potential depends strongly on the energy distribution of the particle environment. In some cases secondary electron emission helps to avoid high negative equilibrium potentials. It can be concluded that materials with high secondary electron yields such as BeCu and SiO_2 have the most useful properties to the extent that highly negative surface charges are avoided in nearly all particle environments that are encountered inside the magnetosphere. (auth)

54055 SUDDEN IMPULSES IN THE GEOMAGNETOTAIL AND THE VICINITY. Patel, V. L. (Univ. of Denver). Planet. Space Sci.; 20: No. 8, 1127-36(Aug 1972).

Explorer-33 magnetic-field observations were analyzed to study the propagation of sudden impulses in the geomagnetic tail and the magnetosheath. Average speed of propagation in these regions is 760 km per sec with a range of 550 to 1230 km per sec. Most of the si's have propagation speed that is close to that of the shock wave observed in this region. Positive si is shown to have a positive change in the tail or magnetosheath and a negative si has a similar negative change. Nine out of thirteen correlated si's have their origin in the solar-wind continuities, while four si's have possible origin in the perturbations of tail or magnetosheath field. It is found that the si propagation is not confined to the tail region but it has correlated effects in the magnetosheath also. The propagation region studied is in 2000 to 0200 local time sector. (auth)

54056 INTERACTION OF A STEADY PLASMA FLOW WITH A DIPOLE MAGNETIC FIELD IN THE PRESENCE OF A RADIAL ELECTRIC FIELD. Kono, Migiwa (Sagami Inst. of Tech., Kanazawa, Japan); Kawashima, Nobuki; Kubo, Haruya. Rep. Ionosphere Space Res. Jap.; 26: No. 1-2, 102-5(1972).

The general layout of an experimental device is shown that simulates the Earth's environmental space. The interactions between the flow of charged particles and the geomagnetic field result in various phenomena such as the formation of the magnetosphere, collision-free shock waves and the plasmapause, and the excitation of aurora. In the experiment, a steady-state plasma is produced in a TP-D device (Takayama, 1966). A plasma diffuses out from the discharge chamber into the experimental region through a small aperture at the center of the anode along a guiding magnetic field. Directions are given for the experiment to simulate the geophysical situation and the relationship between the results and geophysical phenomena such as the plasmapause formation are being studied. (J.C.W.)

54057 SPATIAL DISTRIBUTION OF ENERGETIC PLASMA-SHEET ELECTRONS. Walker, Raymond J.; Farley, Thomas A. (Univ. of California, Los Angeles). J. Geophys. Res.; 77: No. 25, 4650-60(1 Sep 1972).

The spatial distribution of energetic plasma sheet electrons ($E \geq 50$ keV) out to a radial distance of 24 R_E using data from the University of California at Los Angeles electron spectrometer and fluxgate magnetometer experiments on Ogo 5 is presented. A comparison of distributions in geocentric solar magnetospheric coordinates (GSM) prepared with and without the use of a neutral-sheet model indicates that the use of such a model facilitates organization of plasma-sheet data. The distribution in the Y_{GSM}-ZN plane, where ZN is the distance above or below the neutral sheet in the Z_{GSM} direction, for limited values of X_{GSM} shows a tendency for the energetic electrons to concentrate near the neutral sheet. However, no characteristic behavior is seen in electron fluxes during individual neutral sheet crossings. The percentage of flux occurrence above a given flux threshold falls off rapidly with distance from the neutral sheet. Contours of constant percentage of occurrence diverge slightly from the neutral sheet at local times away from midnight. This effect decreases with increasing flux threshold. Contours in the X_{GSM}-Y_{GSM} plane for a limited range in ZN are extended toward dawn, and thus a limited dawn–dusk asymmetry is indicated. This effect is limited to the extent that percentages of occurrence comparable to those on the dawnside are found in the region about midnight. The degree of asymmetry increases as the flux threshold is increased. The contours in the X_{GSM}-ZN plane converge toward the neutral sheet with increasing distance in the antisolar direction ($-X_{GSM}$). A comparison of this result with the results from Imp 1 indicates that X_{GSM} is preferable to the radial distance R for organizing tail data. (auth)

54058 DIAMAGNETIC EFFECT OF THE PLASMA SHEET NEAR 60 R_e. Meng, C.-I. (Univ. of California, Berkeley); Mihalov, J. D. J. Geophys. Res.; 77: No. 25, 4661-9(1 Sep 1972).

The two-dimensional (YZ plane) spatial distribution of magnetic field magnitudes in the geomagnetic tail at the lunar distance is given in both the solar magnetospheric and the neutral-sheet coordinate systems by using 3 years of data from the Ames magnetometer on Explorer 35. The effect of changes in geomagnetic activity is also presented. In the magnetotail near 60 R_E a broad region in which the magnetic field intensity is relatively weak in comparison with that in the other region of the tail is located adjacent to the solar magnetospheric equatorial plane and the calculated neutral sheet. This depression of the field due to the diamagnetic effect of the plasma sheet is more evident during times of minimum geomagnetic activity ($Kp \leq 1+$). Plasma energy densities of 200 to 300 eV/cm^3 in the plasma sheet are inferred by interpreting the field magnitude decrease as the effect of plasma diamagnetism. (33 references) (auth)

54059 BALANCE OF STRESSES IN THE PLASMA SHEET. Rich, F. J. (Rice Univ., Houston, Tex.); Vasyliunas, V. M.; Wolf, R. A. J. Geophys. Res.; 77: No. 25, 4670-6(1 Sep 1972).

The stress resulting from magnetic tension on the neutral sheet must, in a steady state, be balanced by any one or a combination of (1) a pressure gradient in the direction along the axis of the

tail, (2) a similar gradient of plasma flow kinetic energy, and (3) the tension resulting from a pressure anisotropy, with $P_{||} > P_{\perp}$ within the plasma sheet. Stress balance in the first two cases requires that the ratios h/L_x and B_z/B_x be of the same order of magnitude, where h is the half-thickness of the neutral sheet, L_x is the length scale for variations along the axis of the tail, and B_z and B_x are the magnetic field components in the plasma sheet just outside the neutral sheet. The values usually quoted for these quantities do not satisfy this requirement: h is too small and/or B_z is too large. The second case requires, in addition, that the plasma flow speed within the neutral sheet be of the order of or larger than the Alfvén speed outside the neutral sheet. Stress balance in the third case requires that just outside the neutral sheet the plasma pressure obey the marginal firehose stability condition $P_{||} - P_{\perp} = B^2/\mu_0$. (29 references) (auth)

54060 ONSET OF MAGNETOSPHERIC SUBSTORMS. Tsurutani, B. (Univ. of California, Berkeley); Bogott, F. J. Geophys. Res.; 77: No. 25, 4677-81(1 Sep 1972).

An examination of the onset of magnetospheric substorms is made by using ATS-5 energetic particles, conjugate balloon x rays and electric fields, all-sky camera photographs, and auroral-zone magnetograms. It is shown that plasma injection to ATS distances, conjugate 1- to 10-keV auroral particle precipitation, energetic >40-keV electron precipitation, and enhancements of westward magnetospheric electric-field component all occur with the start of slowly developing negative magnetic bays. No trapped or precipitating energetic-particle features are seen at ATS 5 when later sharp negative magnetic-bay onsets occur at Churchill or Great Whale River. (auth)

54061 COORDINATED OBSERVATIONS OF THE MAGNETOSPHERE: THE DEVELOPMENT OF A SUBSTORM. Mende, S. B. (Lockheed Palo Alto Research Lab., Calif.); Sharp, R. D.; Shelley, E. G.; Haerendel, G.; Hones, E. W. J. Geophys. Res.; 77: No. 25, 4682-99(1 Sep 1972).

Coordinated observations of a substorm are reported by using data from all-sky camera (ASCA) stations near the northern conjugate of the ATS 5 geostationary satellite, plasma and magnetic-field experiments on the ATS 5 satellite, Vela 5B at 18 R_E in the magnetotail, the Heos 1 interplanetary probe, and ground-based magnetograms. The substorm event occurred after a very quiet day and was preceded by a development period during which the interplanetary field turned southward and the plasma energy density increased near the Earth (6.6 R_E) on the nightside. This period was also evidenced by a depression of the midlatitude H component of the geomagnetic field at the Earth's surface. The auroral breakup was preceded by the appearance of quiet arcs, the leveling off of the plasma energy density increase at ATS, and the disappearance of the tail plasma at 18 R_E. The onset of the expansive phase was evidenced by brightening and subsequent breakup of the auroral arcs, the development of a westward-traveling surge, an increase in the fluxes of energetic electrons, and the increase of the magnetic field at ATS 5. The ground-based magnetograms show the sudden intensification of the westward electrojet and the appearance of field-aligned currents. (40 references) (auth)

54062 POLAR-CAP ELECTRIC FIELD DISTRIBUTIONS RELATED TO THE INTERPLANETARY MAGNETIC FIELD DIRECTION. Heppner, J. P. (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res.; 77: No. 25, 4877-87(1 Sep 1972).

Measurements were made previously of the electric field during a 13-day period (June 10–22, 1969) when the satellite orbital plane was centered on the 1800–0600 LT meridian. It was shown that, at auroral-belt latitudes in both hemispheres, the electric field is consistently directed poleward in the midevening sector and equatorward in the midmorning sector, whereas the field at higher (polar cap) latitudes is consistently directed from dawn toward dusk, independent of magnetic disturbances, interplanetary-field directions, and other parameters expected to have some relationship to the electric-field pattern. Different characteristic distributions of the polar-cap field reappeared on different days and at a variety of UT throughout the 13 days. An attempt was made to classify the distributions in terms of signatures that could be compared with other geophysical parameters. The distribution of fields within auroral-belt (i.e., sunward convection) regions is ignored, and only the spatial distribution of the dawn–dusk polar-cap field is considered. The northern hemisphere signatures are applied only to passes crossing the noon-midnight meridian between $\Lambda = 75°$ on the nightside and $\Lambda = 85°$ on the dayside. For the southern polar cap, noon–midnight meridian crossings extend from about $\Lambda = 70°$ on the dayside to $\Lambda = 85°$ on the nightside. Classifications for southern and northern polar-cap traverses were made. Correlations between the azimuthal direction of the interplanetary magnetic field and the most simple polar-cap signatures were immediately obvious. (J.C.W.)

54063 ELECTRIC FIELD INDUCED BY A SLOWLY DECAYING RING CURRENT. Wang, C. S.; Kim, J. S. (State Univ. of New York, Albany). J. Geophys. Res.; 77: No. 25, 4867-9(1 Sep 1972).

Magnetic inflation and particle distribution of magnetospheric plasma assure the existence of the ring current. Induction effects of a slowly decaying ring current and model calculations were made to estimate the magnitude of the induced electric field through the equation $\nabla \times E = -\partial B/\partial t$. Calculations are also presented for an electric field induced at the equator by different ring currents having decay time constants of 6, 8, 10, 20, and 40 hours. The ring current is assumed to be at a fixed distance of 4.6 R_E from the Earth. It is known that a continuous slow shift of the location of the ring current occurs, introducing a new electric field. The magnitude of the electric field is evaluated mathematically. (J.C.W.)

54064 SELF-CONSISTENT DESCRIPTION OF THE MAGNETOTAIL CURRENT SYSTEM. Bird, M. K.; Beard, D. B. (Univ. of Kansas, Lawrence). J. Geophys. Res.; 77: No. 25, 4864-6(1 Sep 1972).

The plasma-pressure distribution and magnetic-field configuration of the quiet geomagnetic tail were examined. Electric fields arising from incidence of the solar wind on the magnetospheric field $E = -v/c \times B$ cause a drift of plasma but do not contribute to the current. The structure of the magnetic field and the plasma within and surrounding the plasma sheet of the magnetotail were determined by solving the differential equation for the field, which is obtained by equating the current from Ampere's law to the current obtained from first-order adiabatic drift theory, composed of gradient drift, curvature drift, and magnetization currents. When the plasma distribution and the magnetic field are known, the individual contributions to the total current from the effects of magnetization, curvature drift, and gradient drift may be determined. The solution given shows that 80 to 90% of the current supporting the magnetotail field was due to particle-drift current. Total magnetization current was <20% of the net current per unit length of tail and the remainder entirely due to the drift of magnetosheath solar-wind particles entering and drifting across the equatorial plane primarily because of the curvature of the magnetocylinder field lines within the cavity. (J.C.W.)

54065 DAILY VARIATION OF ELECTRON AND PROTON GEOMAGNETIC CUTOFFS CALCULATED FOR FORT CHURCHILL, CANADA. Smart, D. F.; Shea, M. A. (Air Force Cambridge Research Labs., Bedford, Mass.). J. Geophys. Res.; 77: No. 25, 4595-4601(1 Sep 1972).

The trajectory-tracing process has been used, with an improved mathematical model of the magnetosphere containing magnetic fields of both internal and external origin, to calculate cutoff rigidities for electrons and protons incident at Fort Churchill, Canada. These calculations, made for the vertical direction and at zenith angles of 60°E and 60°W at each hour of the day, give cutoff values of approximately 150 MV during the daytime and less than 20 MV at night. These values are in qualitative agreement with measurements obtained by balloon experiments. (auth)

Solar Wind and Cosmic Ray Interactions

Refer also to abstracts 53968, 54164, 54177, and 54313.

54066 (NASA-TM-X-2440, pp 922-5) NEUTRON SPECTRAL MEASUREMENTS IN THE UPPER ATMOSPHERE. Zobel, W.; Love, T. A.; Delorenzo, J. T.; McNew, C. O. (Oak Ridge National Lab., Tenn.). Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

An experiment to measure neutrons in the upper atmosphere was performed on a balloon flight from Palestine, Texas, at an altitude of about 32 km. The experimental arrangement is discussed briefly, and results of a preliminary analysis of the data for neutrons in the energy range 3 to 30 MeV are given. (auth)

54067 (NASA-TM-X-2440, pp 926-41) PHYSICAL THEORY OF ONE-DIMENSIONAL GALACTIC COSMIC-RAY PROPAGATION IN THE ATMOSPHERE. O'Brien, Keran (Atomic Energy Commission, New York). Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

An essentially analytical theory of atmospheric cosmic-ray propagation is developed on the basis of a phenomenological

model of hadron–nucleus collisions. This model correctly predicts the sea-level cosmic-ray nucleon, pion, and muon spectra, the cosmic-ray ionization profile in the atmosphere, and neutron flux and density profiles in the atmosphere. It is concluded that the large-scale properties of atmospheric cosmic rays can be accurately predicted on the basis of a purely nucleonic cascade as a result of which all secondaries are mediated by pion production. Implications for energy independence of cross sections, the recent 70-GeV results from Serpukhov, and nucleonic relaxation rates in the atmosphere are discussed. 16 figures, 55 references. (auth)

54068 PIONEER 7 OBSERVATIONS OF THE AUGUST 29, 1966, INTERPLANETARY SHOCK-WAVE ENSEMBLE. Dryer, Murray (Space Environment Lab., Boulder, Colo.); Smith, Zdenka K.; Endrud, Glenn H.; Wolfe, John H. Cosmic Electrodyn.; 3: No. 2, 184-207(Jul 1972).

An interplanetary shock wave—possibly due to an importance 2N flare in McMath region 8461 at N23 E22 at 1805 UT on August 26, 1966—was observed by IMP 3, Explorer 33, Explorer 34, and (possibly) Vela 3, at approximately 1315 UT (SSC) on August 29, 1966. The same shock wave, with undiminished velocity, was observed by two plasma instruments and a magnetometer aboard Pioneer 7 when it was about 275 Earth radii downstream of the Earth. Observation of the important plasma parameters of the shocked solar wind for many hours after the shock's passage provided an opportunity to search for a double-shock structure. A time-dependent similarity theory, which incorporates both the effect of the magnetic field and finite electrical conductivity, was used as a guide in this search. The "piston" could not be identified; for example, if present, it was not characterized by an enriched alpha/proton abundance or by peaks in the magnitudes of the proton density or magnetic field as suggested by the theory. A reverse shock was identified within 12 min of its predicted arrival time. Thus, this forward–reverse shock ensemble may be among the first so identified since the speculations of Sonett, Colburn, Schubert, and Cummings. The theoretical energy in the entire disturbance is in excellent agreement with the value determined experimentally, although a detailed comparison of plasma and field parameters between the theory and observations was not successful. A partial explanation for the lack of a detailed comparison (described, at best, as fair) is the neglect in the theory of additional transport properties (thermal conduction and viscosity). A supplemental explanation may be the possibility that the double-shock ensemble was no longer propagating at 1 AU as assumed in the theory, but, instead, had taken on some properties of a blast wave. (auth)

54069 MAGNETOSPHERIC ACCESS OF SOLAR PARTICLES AND THE CONFIGURATION OF THE DISTANT GEOMAGNETIC FIELD. Evans, Lawrence Curtis. Pasadena, Calif.; California Inst. of Tech. (1972). 281p. University Microfilms Order No. 72-22,601.

Thesis.

The access of 1.2- to 40-MeV protons and 0.4- to 1.0-MeV electrons from interplanetary space to the polar-cap regions was investigated with an experiment on board a low-altitude, polar-orbiting satellite (OGO 4). A total of 333 quiet-time observations of the electron polar-cap boundary gave a mapping of the boundary between open and closed geomagnetic-field lines that was an order of magnitude more comprehensive than previously available. Persistent features (north/south asymmetries) in the polar-cap proton flux, which are established as normal during solar proton events, are shown to be associated with different flux levels on open geomagnetic-field lines than on closed field lines. The pole in which these persistent features are observed is strongly correlated to the sector structure of the interplanetary magnetic field and uncorrelated to the north/south component of this field. The features were observed in the north (south) pole during a negative (positive) sector 91% of the time, while the solar field had a southward component only 54% of the time. In addition, changes in the north/south component have no observable effect on the persistent features. Observations of events associated with co-rotating regions of enhanced proton flux in interplanetary space are used to establish the characteristics of the 1.2- to 40-MeV proton access windows: the access window for low polar latitudes is near the Earth, that for one high polar latitude region is ~250 $R_\oplus$ behind the Earth, while that for the other high polar latitude region is ~1750 $R_\oplus$ behind the Earth. All of the access windows are of approximately the same extent (~120 $R_\oplus$). Results are compared to the particle-access predictions of the distant geomagnetic tail configurations proposed by Michel and Dessler, Dungey, and Frank. The data are consistent with neither the model of Michel and Dessler nor that of Dungey. The role played by interplanetary anisotropies in the observation of persistent polar-cap features is discussed. Special emphasis is given to the problem of nonadiabatic particle entry through regions where the magnetic field is changing direction. The degree to which such particle entry can be assumed to be nearly adiabatic is related to the particle rigidity, the angle through which the field turns, and the rate at which the field changes direction; this relationship is established for the case of polar-cap observations. (TSS) (Diss. Abstr. Int., B)

54070 ANALYSIS OF THREE-STATION INTERPLANETARY SCINTILLATION. Armstrong, J. W.; Coles, W. A. (Univ. of California, San Diego, La Jolla). J. Geophys. Res.; 77: No. 25, 4602-10(1 Sep 1972).

Statistical models used in the analysis of drifting random patterns are discussed. A new method of estimating the drift velocity with minimal a priori assumptions is presented. It is shown that all the models that allow for pattern rearrangement, including the new method, can be highly sensitive to systematic errors. These techniques are applied to recent observations of interplanetary scintillation in the ecliptic plane. A comparison is made with mean proton velocities measured by satellite, and a clear correspondence between high velocity features is found. 26 references. (auth)

54071 POLAR-CAP MEASUREMENTS OF SOLAR-FLARE PROTONS WITH ENERGIES DOWN TO 12.4 keV. Mizera, P. F.; Fennell, J. F.; Blake, J. B. (Aerospace Corp., Los Angeles). J. Geophys. Res.; 77: No. 25, 4845-50(1 Sep 1972).

Solar protons with energies down to 12.4 keV were measured over the polar caps by instruments aboard the OV 1–17 satellite. The observations were made following the March 21, 1969, solar-particle event. The polar-cap differential fluxes measured by OV 1-17 and Injun 5 from 0.012 to 1.1 MeV are well represented by a single power law. Over a 22-hour period the spectral index changed from 1.7 to 1.9. Temporal and spatial comparisons were made with data from the Explorer-35 and Injun-5 spacecraft. Good agreement is found at energies (>300 keV) where a comparison can be made. (auth)

54072 SOLAR-WIND AND INTERPLANETARY ELECTRON MEASUREMENTS ON THE APOLLO 15 SUBSATELLITE. Anderson, K. A. (Univ. of California, Berkeley); Chase, L. M.; Lin, R. P.; McCoy, J. E.; McGuire, R. E. J. Geophys. Res.; 77: No. 25, 4611-26(1 Sep 1972).

Measurements of high-energy solar-wind electrons have been made from a low orbit around the Moon. Solar-wind electrons can be identified up to energies of ~3000 eV, at which an electron population of entirely different characteristics becomes dominant. The solar-wind cavity on the Moon's antisolar side shows evidence of being filled by plasma coming from the downstream direction. When the direction of the interplanetary field corresponds to solar ecliptic azimuth angles of about 90°, a partial solar-wind cavity extends across most of the eastern sunlitside of the Moon within ~20° of the noon meridian. There are localized increases in the ~500-eV electron flux over much of the sunlit hemisphere. These increases are highly persistent and stable in their location over a $2\frac{1}{2}$-day period and hence are not due to intrinsic variations in the solar wind. They are usually associated with disturbances in the magnetic field. These increases are interpreted to be the result of an interaction between the solar wind and the Moon that deflects some of the solar-wind flow and results in limb shocks. (auth)

54073 MAGNETOHYDRODYNAMIC THEORY FOR THE INTERACTION OF AN INTERPLANETARY DOUBLE-SHOCK ENSEMBLE WITH THE EARTH'S BOW SHOCK. Shen, Wen-wu (Univ. of Colorado, Boulder); Dryer, Murray. J. Geophys. Res.; 77: No. 25, 4627-44(1 Sep 1972).

The interactions between interplanetary shocks and the Earth's bow shock are formulated first on a gas-dynamic basis. The problem is repeated on a magnetohydrodynamic (MHD) basis for the special case of perpendicular shocks. In particular, an interplanetary double-shock ensemble (composed of forward and reverse shocks) is allowed to interact with the Earth's bow shock. It is found that the collision of a forward shock with the bow shock creates two shocks and a contact surface; the symbolism $S_{\rightarrow}S_{\leftarrow} \rightarrow S_{\leftarrow}CS_{\rightarrow}$ is used to represent this particular interaction. The collision of a reverse shock with the bow shock, hitherto not discussed, yields a shock, contact surface, and rarefaction wave: $S_{\leftarrow}S_{\leftarrow} \rightarrow S_{\leftarrow}CR_{\rightarrow}$. The results of the interactions are discussed on the basis of several representative computations. An order-of-magnitude increase of thermal pressure is the major consequence of the "shock-on-shock" interaction. The effect of the magnetic field is minor; for example, the bow-shock velocity after impact of a forward shock is only ~10% less than the velocity computed on the basis of ordinary gas dynamics. Interaction dynamics are applied, in the case of the geomagnetic storm's sudden commencement, to the characteristic time and energy of the instantaneous compression. Several magnetic-storm sudden-commencement events (in-

cluding the March 8, 1970, event) are discussed on the basis of spacecraft plasma observations and magnetogram records on the Earth. Comparison of available diagnostics with the theory suggests the physical plausibility of the present fluid-dynamic study. (34 references) (auth)

54074 SIMULTANEOUS SOLAR-WIND PLASMA AND MAGNETIC-FIELD MEASUREMENTS IN THE EXPECTED REGION OF THE EXTENDED GEOMAGNETIC TAIL. Intriligator, D. S. (California Inst. of Tech., Pasadena); Wolfe, J. H.; McKibbin, D. D. J. Geophys. Res.; 77: No. 25, 4645-9(1 Sep 1972).

A comparison is made of simultaneous plasma and magnetic-field measurements obtained by Pioneer 7 in the expected region of the geomagnetic tail at ~1000 R_E. The results indicate that, unlike the data for the near-Earth (≤80 R_E) geomagnetic tail, the data for the plasma and magnetic field have no unique signature of tail-associated phenomena. Furthermore, there are differences between the two types of data concerning the tentative identification of tail-associated phenomena for a number of intervals. The physical implications of these differences may be associated with anomalous transport properties that introduce turbulence in the form of mass diffusion and diamagnetic behavior adjacent to plasma eddies. As a result, the magnetopause, as it is recognized close to Earth, loses its identity at far distances (>80 R_E) and combines in a turbulent and hence ill-defined way with the geomagnetic tail. Thus there would be no reason to expect a consistent tail identification on a one-to-one basis with plasma and magnetic-field observations, the criterion presently used close to Earth (i.e., <80 R_E). (auth)

54075 UPPER LIMIT OF THE TORQUE OF THE SOLAR WIND ON THE EARTH. Hirshberg, J. (Ames Research Center, Moffett Field, Calif.). J. Geophys. Res.; 77: No. 25, 4855-7(1 Sep 1972).

An analysis previously presented by Coleman (J. Geophys. Res., 71: 3800(1971)) depended on the assumption that the magnetospheric boundary was held fixed, but no physical mechanism was suggested to prevent the boundary-layer plasma from rotating. It is now shown that there is not enough matter in the solar wind to inhibit the rotation of the boundary-layer might be the cause of some tend to rotate with the Earth, and the possible maximum torque is less than 10^{21} dyne cm and unobservable at 10 R_E. Coleman had suggested torque exerted on the Earth by the solar wind from the coupling between the Earth's ionosphere and the solar-wind plasma in the magnetospheric boundary-layer might be the cause of some of the slower changes in the length of day. The upper limit of the torque is calculated and found to be 3 to 4 orders of magnitude too small to be responsible for the slowing of the Earth's rotation. (J.C.W.)

54076 MAGNETIC-FIELD STRUCTURE IN FLARE-ASSOCIATED SOLAR-WIND DISTURBANCES. Schatten, Kenneth H.; Schatten, Judith E. (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res.; 77: No. 25, 4858-63(1 Sep 1972).

Conclusions were drawn about proposed solar-wind disturbance models by examining the interplanetary magnetic field. Piddington (1958) proposed that material could be ejected from solar flares to form a semipermanent magnetic feature in interplanetary space. Gold (1959) proposed a magnetic tongue or bottle as the field structure being ejected by these active regions. The interplanetary-field increase that might be associated with the additional outburst of a Gold bottle was described. A Gold bottle could also have a shock and/or compressed ambient field region in front of it. Later Gold (1962) proposed a model where field-line reconnection occurred, closing magnetic loops being ejected by the flare. Thus, the looped field lines attached to the active region would tie off in interplanetary space, and any radial field increase observed would be short-lived. Coleman et al. (1960) used measurements showing a null in the interplanetary magnetic field that might fit Gold's model. Parker considered both a blast-wave model and drive-disturbance model. Data from fifteen solar-wind disturbances (1965 to 1967) associated with solar flares and available interplanetary field data were used. (J.C.W.)

PHYSICS (ATOMIC AND MOLECULAR)

Atomic, Electron, Ion, and Molecular Beams and Their Reactions

Refer also to abstracts 52936, 53322, 54105, and 54467.

54077 (CEA-CONF-2048) MEASUREMENT OF THE ABUNDANCE OF A $^{14}N^{7+}$ ION BEAM. Geller, R. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). 1972. 6p. (In French). (CONF-720120-3). Dep. NTIS (U. S. Sales Only).

From Conference on the sources of multicharged ions; Paris, France (28 Jan 1972).

The $^2H^+$ ion abundance is minimized by establishing a vacuum limit of 10^{-9} torr. A time-of-flight method is used to separate the $^{14}N^{7+}$ ions from the other nitrogen ions, after having accelerated the ions by very short pulses. Obstacles inside the flight tube minimize the diffusion plasma. The abundance can be measured only for beams with an extraction intensity lower than 10 μA. The detection system consists in a secondary emission target associated with a scintillator and a photomultiplier. The fast electronics (time constants < 30 ns) includes a linear gate variable in time with a 100 ns time duration. (France)

54078 (CEA-CONF-2050) X-RAY SPECTROMETRY BETWEEN 5A AND 20A. APPLICATION TO THE MULTIPLY-CHARGED ION EXPERIMENT. Jacquot, C. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). 14 Mar 1972. 5p. (In French). (CONF-720120-5). Dep. NTIS (U. S. Sales Only).

From Conference on the sources of multicharged ions; Paris, France (28 Jan 1972).

The principle for the most suitable x-ray-spectrometry unit, a compromise between high sensitivity and good spectral resolution, in the 500-eV to 10-keV energy range (1A to 20A) is discussed. This spectral range was selected for use in proving the existence of stripped ions in the stripped-ion experiment at the electron cyclotron resonance and determining the abundance ratio for the stripped nitrogen ions. (France)

54079 (FRNC-CONF-53) RESEARCH PROGRAM OF THE PARTICLE SOURCE GROUP IN THE FIELD OF MULTICHARGED IONS. Gautherin, G.; Lejeune, C. (Paris Univ., Orsay (France)). 1972. 18p. (In French). (CONF-720120-10). Dep. NTIS (U. S. Sales Only).

From Conference on the sources of multicharged ions; Paris, France (28 Jan 1972).

The possibilities of discharges with magnetic and geometric compression (duoplasmatron) were studied. Various structures were envisaged (duopigatron, triplamatron, hot-cathode magnetron) with regard to obtaining a multicharged-ion source with the following specifications: continuous pulsed operation, weak energy dispersion and emittance, easy utilization (volume, power, complexity, vacuum). (France)

54080 (FRNC-CONF-55) SOURCES WITH CONFINED ELECTRON BEAMS (REVIEW). Baron, Eric (Paris Univ., Orsay (France). Institut de Physique Nucleaire). 1972. 17p. (In French). (CONF-720120-8). Dep. NTIS (U. S. Sales Only).

From Conference on the sources of multicharged ions; Paris, France (28 Jan 1972).

The various types of ion sources with confined electron beams are surveyed, the toroidal HIPAC system being excluded: the Redhead device, the Dubna source, and the MEBIS source. The difficulties involved in these sources are emphasized, and their performances are discussed. (France)

54081 (FRNC-CONF-57) PRELIMINARY STUDIES ON A MODIFIED VERSION OF THE EBIS SOURCE. Septier, A.; Brebec, J. M.; Ambourg, Y. (Paris Univ., Orsay (France)). 1972. 9p. (In French). (CONF-720120-12). Dep. NTIS (U. S. Sales Only).

From Conference on the sources of multicharged ions; Paris, France (28 Jan 1972).

The principle of the MEBIS source is presented. This source should offer the following performance: a working pressure higher than that of the EBIS source, a reduction in the electric power supply, a continuous operation. The electric power used for the focusing system should be reduced and a longitudinal ion trapping should be obtained by replacing the homogeneous focusing magnetic field by a system with alternate magnets. (France)

54082 (FRNC-CONF-58) PROJECT FOR THE SPECTROSCOPIC STUDY OF A PIG ION SOURCE. Dufay, M. (Paris Univ., Orsay (France). Institut de Physique Nucleaire). 1972. 2p. (In French). (CONF-720120-9). Dep. NTIS (U. S. Sales Only).

From Conference on the sources of multicharged ions; Paris, France (28 Jan 1972).

In a first stage a bulk statistical study is envisaged followed by a spatial resolution study. In a second stage, a dynamical study of the processes involved in the plasma formation and evolution is envisaged. (France)

54083 SCATTERING OF LOW-ENERGY RARE-GAS IONS FROM TUNGSTEN. Krauss, Roland Henry. Charlottesville, Va.; Univ. of Virginia (1972). 71p. University Microfilms Order No. 72-22,636.

Thesis.

Angular and energy distributions of He^+, Ne^+, and Ar^+ ions scattered from a clean polycrystalline tungsten surface with incident energies ranging from 150 to 1000 eV were measured. Scattering angles ranged from 45 to 100 degrees for He^+ scattering and from 30 to 100 degrees for Ne^+ and Ar^+ scattering. The energy distributions of ions scattered from a clean target surface are almost entirely typical of single collisions of the incident ions with effectively free tungsten atoms. Results are reported as the number of ions scattered per second within the solid angle of the detector vs. the scattering angle and also as the ratio of measured ion scattering cross section for scattering from a single layer of surface atoms to cross sections for single collisions with surface atoms obtained using a Bohr potential model. The ratio of measured ion scattering cross section to calculated cross section is always less than .07. (Diss. Abstr. Int., B)

54084 ION EMISSION FROM ELECTRON-BOMBARDED SOLIDS AND MASS-SPECTROMETER APPLICATIONS. Tsigel'man, G. E. (Special Design Bureau for Analytic Instrument Construction, Leningrad). Sov. Phys.-Tech. Phys. (Engl. Transl.); 17: No. 3, 525-7(Sep 1972).

Translated from Zh. Tekh. Fiz.; 42: No. 3, 667-9(Mar 1972).

Experimental measurements of the ion and neutral components in vapor emitted from bombarded solids (Ni, Al_2O_3, and NaCl) by a high-energy electron beam are described. Mass-spectrometer applications are considered. (auth)

54085 SURFACE AND VACUUM PHYSICS INDEX. VOLUME 7, No. 6, 1972. Bibliography, Author Index, Subject Index in Alphabetical Order, Cumulative Subject Index in Logical Order. Leopoldshafen, Ger.; Zentralstelle fuer Atomkernenergie-Dokumentation (1972). 74p.

This listing contains 269 references on various aspects of surface and vacuum physics. (M.O.W.)

54086 ION FOCUSING OF AN ELECTRON BEAM IN A TRANSVERSE GAS FLOW. Bliokh, P. V.; Glutsyuk, A. M.; Nazarenko, O. K.; Pats'ora, S. K. Radio Eng. Electron. Phys. (USSR) (Engl. Transl.); 16: No. 11, 1930-5(Nov 1971).

Translated from Radiotekh. Elektron.; 16: No. 11, 2183-9 (Nov 1971).

A theoretical analysis is presented of ion focusing of an electron beam under transverse gas flow conditions. For the experimental work, relative motion was created by moving the electron beam in a stationary gas. It is shown that the defocusing action of the space charge is observed at lateral electron beam velocities ≥ 1 km/sec. Experiments were performed with an electron beam 14 m long; the beam power was 0.4 to 3 kW for accelerating voltages of 20 to 60 kV. The residual gases were air, argon, and helium; the vacuum was 10^{-3} to 10^{-6} mm Hg. (auth)

54087 DETERMINATION OF ATOM–SURFACE PROPERTIES FOR Ne–LiF BY SCATTERING STUDIES. McClure, J. Doyle (Boeing Scientific Research Labs., Seattle). J. Chem. Phys.; 57: No. 7, 2823-9(1 Oct 1972).

The preceding paper (J. Chem. Phys., 57: 2810(1972)) contains a quantitative comparison of calculated and experimental intensity distributions for atomic beams of Ne scattered from the (001) LiF surface. Those results imply self-consistency of both the scattering model and the semiempirical atom–surface potential derived from the study, since a large number of observables are predicted on the basis of a semiempirical potential determined by appropriate choice of three disposable parameters. A systematic trials study used both to determine these potential parameters from a limited part of the experimental data and to assess the significance of uncertain values of other parameters associated with the scat-

tering model is reported here. The trials study clarifies mechanisms associated with scattering phenomenology and permits one to identify characteristic features of the colorful intensity structure (surface rainbows) with specific physical parameters that influence the atom–surface interaction. The use of scattering theory to extract atom–surface properties from experimental observables is dependent on the latter relationship. (auth)

54088 HIGH-RESOLUTION CALCULATIONS ON ATOM–SURFACE SCATTERING: METHOD AND COMPARISON WITH EXPERIMENT FOR Ne–LiF. McClure, J. Doyle (Boeing Scientific Research Labs., Seattle). J. Chem. Phys.; 57: No. 7, 2810–22(1 Oct 1972).

Calculated scattering distributions for Ne on (001) LiF are compared with corresponding experimental distributions. For calculational purposes, the surface is effectively modeled by a monolayer of 3D harmonic oscillators representing F^- ions. The atom–surface potential at close range is assumed to arise from two-body dispersion–exchange interactions, which are represented by superposed Lennard–Jones (12, 6) model potentials. The foregoing potential is shown to be large with respect to that due to induced-dipole interaction. The long-range van der Waal's potential, for which the strength is independently specified, is taken to be one-dimensional in nature. The classical trajectory method combined with Monte Carlo distribution of surface impact coordinates and thermal states of gas surface atoms is used to determine angular distributions of scattered beam intensity. Physical concepts underlying an efficient calculational algorithm required for high-resolution scattering calculations are described. For a variety of incident beam conditions, including variation of beam "temperature," angle of incidence, and azimuth of the plane of incidence, calculated angular positions of dominant intensity peaks in the scattered beam typically agree with experimental determinations to within 3 to 5°. Predictions of high-intensity "ridge" structure, which is quite different in form for the ⟨010⟩ and the ⟨110⟩ planes of incidence, are confirmed by experimental studies undertaken elsewhere. Calculated values of absolute scattering probability in the plane of incidence typically agree with prior experimental determinations to within 10 to 15%. Statistical fluctuations in the calculated intensities (~5 to 10% of the calculated value) preclude a rigorous determination of whether or not the model reproduces all observed substructure on the high-intensity ridges. The parameters defining the semiempirical Ne–LiF potential used in the present study correspond to a heat of adsorption of ~0.016 eV and to a two-body range parameter of 3.9 Å. Means for determination of the potential parameters from a small part of the available experimental data and means for assessing the accuracy of these values are reported in a companion paper. (auth)

54089 MODEL FOR THE REPULSIVE ELASTIC SCATTERING OF ATOMS BY SOLID SURFACES. Goodman, Frank O. (Univ. of Waterloo, Ont.); Liu, William S.; Cabrera, Nicolas. J. Chem. Phys.; 57: No. 7, 2698–2702(1 Oct 1972).

A model is developed, enabling the intensities of diffracted beams to be calculated in closed form, starting from a pairwise (Yukawa-type) interaction law between a gas atom and a solid atom. The treatment is more satisfying than most previous treatments, which calculate the diffracted intensities as functions of empirical parameters describing the overall gas–solid interaction, without reference to the microscopic (pairwise) interaction. The model is illustrated by an application of the He–LiF system. (auth)

Atomic and Molecular Properties

Refer also to abstracts 53803, 54111, 54134, 54145, and 54375.

54090 OBSERVABILITY OF THE H_3^+ FUNDAMENTAL SPECTRUM. Patch, R. W. (Lewis Research Center, Cleveland). J. Chem. Phys.; 57: No. 6, 2594–5(15 Sep 1972).

Two studies of the possibility of observing the dipole-allowed fundamental transition in H_3^+ in an infrared absorption experiment are reported briefly. The first study was based on a box model for the fundamental band, which is a reasonable approximation if the spectral lines overlap. The second study was based on the assumption that the H_3^+ fundamental has discrete lines rather than the overlapping lines assumed in the box model. It is concluded that the H_3^+ spectrum would be difficult to observe in the laboratory, but there is a good possibility that it could be observed in high-resolution measurements of the spectra of stars or planets if infrared absorption by the Earth's atmosphere were eliminated. (A.G.W.)

54091 PHOTOIONIZATION OF EXCITED H_2 MOLECULES. Cohn, Arthur (Air Force Cambridge Research Labs., Bedford, Mass.). J. Chem. Phys.; 57: No. 6, 2456–8(15 Sep 1972).

The photoionization cross sections of the singly excited H_2 states are calculated. The Coulomb approximation method utilizing the Temkin–Vasavada electron–H_2^+ scattering phase shifts is used. Cross sections of ~1 to 2×10^{-17} cm^2 are found for all states at threshold, the same range as found for H (n = 2) atoms. (auth)

54092 PERTURBATION CALCULATION OF THE NUCLEAR SPIN–SPIN COUPLING CONSTANT IN HD BASED ON THE BARE-NUCLEUS POTENTIAL. Schulman, Jerome M.; Kaufman, D. Neal (Polytechnic Inst. of Brooklyn). J. Chem. Phys.; 57: No. 6, 2328–32(15 Sep 1972).

Perturbation calculations of the Fermi contact part of the electron-coupled nuclear spin–spin coupling constant (J) in the HD molecule were performed in the bare-nucleus potential. A very large Gaussian basis was employed, and, in addition, the effect on J of varying the HD internuclear separation was considered. The term zeroth order in correlation, J_0, is in good agreement with an independent basis set study as is the geometric approximate to the coupled Hartree–Fock value. The J_0 and J_1 values reported here differ significantly from those reported in a recent bare-nucleus perturbation study using numerical H_2^+ orbitals. A refined value of previous Hartree perturbative results based on this larger atomic basis set is given. (auth)

54093 ONE DIMENSIONAL HYDROGEN ATOM WITH A REPULSIVE CORE. Care, C. M. (Univ. of Sheffield, Eng.). J. Phys., C (London); 5: No. 14, 1799–1805(24 Jul 1972).

The problem of an electron moving in a one-dimensional Coulomb potential $e^2/|x|$ is of interest in connection with the energy levels of the hydrogen atom in a strong magnetic field. It is shown that the ground-state energy of the one-dimensional hydrogen atom is profoundly changed if a repulsive core is included in the Coulomb potential. The sensitivity of the ground-state energy to this repulsive potential is investigated, and it is found that if the core is sufficiently "hard" the ground-state energy is very nearly the first Balmer energy. The results appear to be relevant to the Yafet–Keyes–Adams (J. Phys. Chem. Solids, 1: 137 (1956)) theory of a hydrogen atom in a strong magnetic field and suggests that this theory may need modification. (auth)

54094 LIGHT-INTENSITY DEPENDENCE OF THE MULTIPHOTON IONIZATION PROBABILITY IN THE RESONANCE CASE. Bakos, J.; Kiss, A.; Szabo, L.; Tendler, M. (Central Research Inst. for Physics, Bupadest). Phys. Lett.; 41A: No. 2, 163–4(11 Sep 1972).

The general intensity dependence of the five-photon ionization probability of triplet metastable helium was measured. (auth)

54095 OPTICAL 4d → 4f TRANSITION AND THE BINDING ENERGY OF THE 4d LEVEL IN La AND Ce. Suzuki, S; Nagakura, I.; Ishii, T.; Satoh, T.; Sagawa, T. (Tohoku Univ., Sendai). Phys. Lett.; 41A: No. 2, 95–6(11 Sep 1972).

The comparison between the optical absorption spectra due to the 4d → 4f transition and the photoemission lines due to 4d electrons in lanthanum and cerium shows that a simple-band theoretical interpretation cannot be applied to the 4d → 4f transition. (auth)

Positronium, Muonium, and Mesic Atoms and Molecules

Refer also to abstracts 54119, 54568, and 55064.

54096 PRODUCTION OF MUONIUM IN A VACUUM BY DIFFUSION FROM A HOT METAL FOIL. Kendall, Kenneth Robert. Tucson, Ariz.; Univ. of Arizona (1972). 79p. University Microfilms Order No. 72-21,437.

Thesis.

The first observation of muonium produced in a vacuum is reported. A special very-low-momentum muon channel is described. The muon production technique yields a 100% polarized beam. The muons were stopped in a 0.001" metal foil. When the foil is heated, muonium is produced by muons diffusing to the foil surface and evaporating into an evacuated chamber. Production rates for the metals Pt, W, Mo, and Ta were measured. Approximately 10% of the stopping beam can be made to form muonium by this method. The application of this technique to search for muonium–antimuonium conversion is discussed. By taking advantage of the similarity between muons and hydrogen in solids this technique may be used as a probe for studying gas–solid chemistry on a microsecond time scale. (Diss. Abstr. Int., B)

54097 DOPPLER BROADENING OF POSITRON ANNIHILATION PHOTONS IN SILVER HALIDE CRYSTALS FOLLOWING HIGH-ENERGY IMPLANTATIONS OF C^{6+}, N^{5+}, O^{6+}, AND S^{6+}. Leber, R. Eric; Lambrecht, Richard M. (Brookhaven National

Lab., Upton, N. Y.). J. Chem. Phys.; 57: No. 6, 2273-6(15 Sep 1972).

The Doppler broadening of positron annihilation photons detected by a Ge(Li) detector was employed to probe the interactions of positrons in high purity AgCl and Ag Br (95%) + AgCl sheet crystals that had been exposed to 10^{11} to 10^{13} ions cm^{-2} of implanted $^{12}C^{5+}$, $^{14}N^{5+}$, $^{16}O^{6+}$, or $^{32}S^{6+}$. The narrowing of the Doppler broadened spectrum varied with the implanted ion, the concentration of the dopant, and the composition of the halide crystals. The decrease in linewidth is attributed to the electronic environment of the defects and an increased probability of annihilation of near-thermal positrons with conduction electrons relative to annihilation with core electrons. (auth)

54098 ELECTRIC MULTIPOLE TRANSITIONS IN MESIC ATOMS. Savushkin, L. N. Vestn. Leningrad. Univ., No. 22, Fiz., Khim.; No. 4, 146-7(Nov 1971). (In Russian).

The corrections to the long-wavelength approximation in the example of x radiation from heavy muonic atoms were estimated. The transitions of electric type are considered, with the relativistic hydrogen-like wave functions being used for the calculations. In the case of muonic ^{208}Pb the corrections to the long-wavelength approximation appear to be essential. (auth)

54099 DEPOLARIZATION OF NEGATIVE MUONS IN WATER AND AQUEOUS SOLUTIONS. Dzhuraev, A. A.; Evseev, V. S.; Obukhov, Yu. V.; Roganov, V. S. (Joint Inst. for Nuclear Research, Dubna, USSR). Zh. Eksp. Teor. Fiz.; 62: No. 6, 2210-20(Jun 1972). (In Russian).

The dependence of negative-muon depolarization on temperature and hydrogen peroxide concentration is measured in various aqueous solutions located in longitudinal or transverse magnetic fields. It is shown that the experimental data are not inconsistent with the familiar concepts regarding the behavior of free radicals in aqueous solutions. The residual polarization in a water solution of hydrogen peroxide is found to be 1.8 times higher than that in pure water. This is interpreted as being the result of chemical interaction between mesic nitrogen and hydrogen peroxide molecules leading to the formation of diamagnetic compounds. It is shown that the degree of depolarization does not depend on the magnetic field strength. According to the depolarization model in which mesic-nitrogen chemical reactions are taken into account, this signifies that the mesoatom enters the chemical reactions during a time $t \approx 10^{-11}$ s at T = 300°K; the paramagnetic products of these primary reactions involving mesic-nitrogen then participate in secondary reactions during a time $t_1 \lesssim 10^{-7}$ s. The rate constants of the reactions leading to the formation of diamagnetic products can be obtained by treating the concentration and temperature dependences of depolarization in an aqueous solution of hydrogen peroxide in accordance with the model assuming chemical reactions between the mesoatom and H_2O_2 molecules. The order of magnitude of the constant $k \approx 3 \times 10^{-11}$ $s^{-1} \cdot cm^3$ is the same as that of the constant for reactions between free H and OH radicals in water. The temperature dependences of residual depolarization in water and a water solution of hydrogen peroxide are the same and consistent with the concept that the mesic-nitrogen reactions are chemical reactions limited by diffusion. (auth)

54100 INTENSITY OF ORTHO-POSITRONIUM COMPONENT IN LIQUID AND SOLID AMIDES. Ito, Yasuo; Tabata, Yoneho (Tokyo Univ.). Chem. Phys. Lett.; 15: No. 4, 584-5(1 Sep 1972).

Lifetime measurements of positrons in polar media were made. It was suggested from the experiments that positrons are captured in liquid or amorphous media, owing to the strong dipolar electric field of polar groups that are free from surrounding molecules. (auth)

Collision Phenomena

Refer also to abstracts 54008, 54033, 54279, and 54280.

54101 (EUR-CEA-FC-630) LARGE-ANGLE SCATTERING OF NEUTRAL PARTICLES IN THE 40 TO 100 keV RANGE. Eliot, M. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Feb 1972. 101p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Paris Univ., Orsay (France).

The angular distributions of elastically scattered neutral particles (atoms) were measured for different projectile–target systems for energies in the 40- to 100-keV range. The experimental angular-distribution curves are compared with the theoretical differential-cross-section curves. This comparison demonstrates that for the light systems studied the Po = No/N ratio remains constant and independent of the energy of the incident particle. The results are consistent with those obtained for ion–atom collisions. In contrast, heavy systems present angular distributions decaying more rapidly than the theoretical curves. Information on the importance of ionization phenomena in relation to the angle and energy can be derived from these distributions. The close association between the form of the angular distributions and the distance of closest approach in relation to the scattering angle was also demonstrated. The differential cross sections, distances of closest approach, and the impact parameters were determined as a function of the b/a parameter for angles between 2° and 175° (center of mass system). These calculations were made using the Thomas–Fermi potential in the Firsov approximation. (France)

54102 (EUR-CEA-FC-644) ENERGY SPECTRA OF THE DISSOCIATION PRODUCTS OF CH_n^+ IONS ($1 <= n <= 5$) WITH A MOLECULAR NITROGEN TARGET. Julienne, A. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). May 1972. 65p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Paris Univ., Orsay (France).

The various collisional dissociation reactions of CH_n^+ ions were studied with respect to production of H^0 neutral particles. The important role of the vibrations in molecular-ion predissociation is demonstrated, and the most probable electronic states of CH^+ ions before collision are determined from the various lifetimes of the competing processes. The correlations between certain states of CH_3, CH_3^+, and their dissociation products are studied. The experimental conditions, the measuring method, and the cms transformation of the energy spectra are briefly described. The spectra from CH^+ and CH_n^+ dissociation ($2 <= n <= 5$) are studied in detail. (France)

54103 (FRNC-CONF-51) PROCESSES OF FORMATION OF MULTIPLY CHARGED IONS BY ELECTRON IMPACT. Abouaf, R. (Paris Univ., Orsay (France)). 1972. 21p. (In French). (CONF-720120-6). Dep. NTIS (U. S. Sales Only).

From Conference on the sources of multicharged ions; Paris, France (28 Jan 1972).

The various processes involved in atom ionization by electrons with an energy between 0 and a few keV are surveyed: the direct process involving the ejection of one or many electrons from the outer shells, and the processes associated with preionization with the ejection of an electron from an inner shell. The radiative and nonradiative (Auger) reorganization processes are considered for Ne, Kr, and W; the shake-off process is also envisaged. The cross sections obtained for Ca^{2+}, Sr^{2+}, Al^{2+}, Al^{3+}, In^{7+}, and In^{8+} are given. (France)

54104 K-SHELL IONIZATION CROSS SECTIONS FOR 2.04-MeV ELECTRONS. Scholz, W. (State Univ. of New York, Albany); Li-Scholz, Angela; Colle, R.; Preiss, I. L. Phys. Rev. Lett.; 29: No. 12, 761-4(18 Sep 1972).

K-shell ionization cross sections were measured at 2.04-MeV incident electron energy for 32 elements from V (Z = 23) to Bi (Z = 83). Measured cross sections drop from a value of 353 b at V to 9.9 at Bi. The general trend of the Z dependence of the cross sections is in agreement with theoretical predictions of Kolbenstvedt. However, variations in cross sections by as much as 30% from one element to the next are not accounted for by the theory. (auth)

54105 STRIPPING IN COLLISIONS BETWEEN HYDROGEN MOLECULES. Peterson, Robert Keith. Houston, Tex.; (Univ. of Houston (1971). 92p. University Microfilms Order No. 72-22,361.

Thesis.

The cross sections for the production of fast molecular ions in collisions of H_2 on H_2 and D_2 on D_2 were measured at lab kinetic energies between 50 and 500 eV. The cross section for the H_2 reaction ranges from 2.2×10^{-17} cm^2 at 500 eV to 5.0×10^{-19} cm^2 at 50 eV. The D_2 cross section varies from 1.7×10^{-17} to 3.8×10^{-19} cm^2 in the same energy range. The angular dependence of the reaction products was found to be highly peaked in the forward direction so that for the geometry used, practically all fast ions left the collision chamber for energies above 100 eV. The angular loss was found to be within reasonable limits at the lowest energies. The total stripping cross sections for H_2 and D_2, when plotted vs. incident velocity, are found to approach the same values at the highest velocities. The two cross sections diverge toward lower velocities as they approach their respective cutoffs where each process becomes energetically impossible. These cross sections have been found to fit a theoretical model based on ideas first presented by Demkov and Komarov (Sov. Phys. JETP, 23: 189(1966)), in which ionization is presumed to take place via a series of pseudocrossings of the initial state into the continuum of the adiabatic states of the collision complex. For the interaction of two hydrogen molecules, the internuclear separation of each molecule is assumed fixed and the adiabatic states are defined in terms of the distance between the two molecular centers (R). Best agree-

ment between the observed cross sections and those predicted from the model is obtained by assuming the transition region to be centered around R = .43 A, 16.5 eV above the energy of the ground state at large R. For the purpose of monitoring the neutral beam intensity, the secondary-electron emission coefficients (γ) were measured for H_2 and D_2 impinging on a brass surface. The γ values were found to vary from .77 and .65 at 500 eV to .045 and .020 at 50 eV for H_2 and D_2, respectively. (auth) (Diss. Abstr. Int., B)

54106 DISTORTED-WAVE THEORY AND ITS APPLICATION TO THE EXCITATION OF THE ^1p STATES OF HELIUM AND MERCURY. Madison, Don Harvey. Tallahasse, Fla.; Florida State Univ. (1972). 188p. University Microfilms Order No. 72-21,319.

Thesis.

Theoretical results are given for the application of the distorted-wave approximation to the excitation of atoms by electron impact. The antisymmetrized atomic wave functions are assumed to be L–S coupled initially and arbitrarily coupled finally. Expressions for the differential cross section and spin polarization of the emitted electrons are given for unpolarized electron beams incident upon unpolarized atoms. These results are applied to the excitation of the 1s2p $^1P_1$ state of helium and the excitation of the 6s6p $^1P_1$ state of mercury. For the case of helium, differential and integral cross sections are given for incident-electron energies between 26.5 and 300 eV. The distorted-wave results are compared with experimental work and previous theoretical work. It is found that the distorted-wave calculations are superior to the previous theoretical calculations in fitting the absolute magnitude and angular distribution of the experimental data. Almost complete agreement with experiment is obtained for the higher energies. For the case of mercury, differential cross sections and spin polarizations of the emitted electrons are given for incident-electron energies between 25 and 180 eV. The distorted-wave calculations are compared with unnormalized experimental data and with the plane-wave Born approximation. It is found that the distorted-wave results give good agreement with the experimental spin polarizations and with the shape of the experimental differential cross sections. Again almost complete agreement with experiment is obtained for the higher energies. For both atoms, it is found that the differential cross sections given by the Born approximation fail by several orders of magnitude at large angles. (Diss. Abstr. Int., B)

54107 WKB APPROXIMATION IN TIME-DEPENDENT SCATTERING THEORY, INCLUDING REARRANGEMENT PROCESSES. Eu, Byung Chan (McGill Univ., Montreal). J. Chem. Phys.; 57: No. 6, 2531-7(15 Sep 1972).

The classical correspondence of the S matrix for scattering processes is examined with a view to obtaining the classical approximation and also to clarifying the nature of the approximations required for the classical formula. In this discussion the Schroedinger equation in the momentum representation is employed instead of the usual coordinate representation in order to provide a more direct route to the classical limit of the S matrix. The S matrix thus obtained essentially corresponds to the WKB approximation, and, with a further approximation, leads to Miller's expression except for a multiplicative factor and an additional phase which are in general not equal to 1 and 0, respectively. The classical limit is also discussed in terms of the Wigner–Moyal phase space distribution function, and, when the classical limit of this function is taken, an additional factor and phase appear in the S matrix. (auth)

54108 STUDY OF ELECTRON EXCITATION CROSS SECTIONS OF THE HELIUM ATOM AND NITROGEN MOLECULE. Chung, Sunggi. Norman, Okla.; Univ. of Oklahoma (1972). 185p. University Microfilms Order No. 72-22,438.

Thesis.

The formalism of the close-coupling method is used to study the indirect coupling effects on cross sections for electron-induced excitation of atoms via intermediate states. It is found that the indirect coupling potentials are as important as or even more important than the direct coupling potential in the case of excitation to dipole-forbidden states, whereas they are not too important in the case of excitation to dipole-allowed states. A detailed examination is presented as to the important intermediate states that must be considered given the initial and final states of excitation. The sensitivity of the computed cross sections to the accuracy of the wave functions used in the computation is also presented. Excitation cross sections of the nitrogen molecule were also studied. Application of Gaussian-type orbitals to the computation of excitation cross sections of electronic states of the nitrogen molecule reduces the computational complexity to the level of the corresponding atomic case. The excitation cross sections of twelve electronic states of the nitrogen molecule are presented. The Born approximation was used throughout; however, the exchange effects were included by means of Ochkur's and Rudge's modifications of the Born–Oppenheimer approximation. Four different sets of wave functions are used to determine how the computed cross sections depend on the accuracy of the wave functions employed in computation, including the one with Gaussian-type basis functions calculated here. (TSS) (Diss. Abstr. Int., B)

54109 TIME-OF-FLIGHT ANALYSIS OF NEUTRAL PRODUCTS FROM INELASTIC ION–MOLECULE COLLISIONS. Conrads, R. J.; Pomerance, W.; Moran, T. F. (Georgia Inst. of Tech., Atlanta). J. Chem. Phys.; 57: No. 6, 2648-71(15 Sep 1972).

Cross sections for inelastic charge-transfer reactions producing neutral excited atoms were measured for the interactions of 500- to 1500-eV He^+ ions with He. Time-of-flight methods coupled with post acceleration techniques were used to separate neutral from charged products of ion–molecule reaction. The position of inelastic peaks appearing in the neutral product energy loss spectra is consistent with the excitation of colliding particles to known spectroscopic excitation potentials with the relative importance of inelastic scattering decreasing as the reactant ion kinetic energy is lowered. (auth)

54110 COLLISIONS OF FAST ELECTRONS WITH HELIUM. 2. IDENTITIES SATISFIED BY THE SECOND BORN SCATTERING AMPLITUDE. Woollings, M. J. (Royal Holloway Coll., Englefield Green, Eng.). J. Phys., B (London); 5: No. 8, L164-6 (Aug 1972).

It is shown that the second Born scattering amplitude satisfies relationships analogous to the optical theorem and the dispersion relation of Gerjuoy and Krall (Phys. Rev., 119: 705(1960)). (auth)

54111 SUPERHEAVY ELECTRONIC MOLECULES. Rafelski, J.; Mueller, B.; Greiner, W. (Univ., Frankfurt am Main). Lett. Nuovo Cim.; 4: No. 11, 469-74(15 Jul 1972).

The possibility that the two nuclei involved in heavy-ion collisions may approach so closely that even the inner electrons belong to both nuclei is considered. The effective potential for the resulting superheavy molecule is defined and calculated. The calculations are based on two assumptions: that the movement of the nuclei is adiabatic compared to that of the electrons and that the inner shells are filled with electrons. It is concluded that the formation of intermediate superheavy electronic molecules will lead to deviations from the standard Rutherford scattering and will show up particularly in the angular distribution. (A.G.W.)

54112 ELECTRON EMISSION IN NEGATIVE ION AND ATOM COLLISIONS IN THE SUDDEN-SWITCHING APPROXIMATION. Bronfin, F. B.; Ermolaev, A. M. Vestn. Leningrad. Univ., No. 22, Fiz., Khim.; No. 4, 29-34(Nov 1971). (In Russian).

A nonstationary quantum problem in which the bound state of a quantum system first approaches and then for a certain time merges with the continuous energy spectrum because of the variation of an external parameter was considered. The above conditions may occur during the collisions between negative ions and atoms. The energy distribution of the emitted particles (electrons) was obtained and the probability of the emission was determined. (auth)

54113 DETERMINATION OF ABSOLUTE DIFFERENTIAL CROSS SECTIONS FOR THE $1^1S \rightarrow 4^1D$ TRANSITION OF THE HELIUM ATOM. Peresse, J.; Pochat, A.; Gelebart, F. (Faculte des Sciences, Brest, France). Phys. Lett.; 41A: No. 2, 135-6 (11 Sep 1972). (In French).

Absolute differential cross sections are determined by measuring delayed coincidences between inelastically scattered electrons and the subsequent decay photons. Preliminary results are given for the $1^1S \rightarrow 4^1D$ transition of helium. (auth)

54114 ISOTOPE DEPENDENCE OF K-SHELL IONIZATION CROSS SECTIONS BY ^{20}Ne AND ^{22}Ne BOMBARDMENTS. Takasaki, M.; Shima, K.; Terashima, Y.; Sakai, S. (Kyoto Univ.). Phys. Lett.; 41A: No. 2, 181-2(11 Sep 1972).

Ionization cross sections of Mg and Al K shells were measured by bombarding with 0.7- to 7.4-MeV ^{20}Ne and ^{22}Ne isotopes. No isotope dependence was observed within experimental error; this agrees with a theory based on Coulomb deflection. (auth)

54115 CHARGE STATE ALTERATION PROCESSES IN COLLISIONS OF HYDROGEN ATOMS WITH HYDROGEN MOLECULES. Afrosimov, V. V.; Leiko, G. A.; Mamaev, Yu. A.; Panov, M. N.; Fedorenko, N. V. (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Eksp. Teor. Fiz.; 62: No. 6, 2049-59 (Jun 1972). (In Russian).

The cross sections for all elementary processes of charge-state changes in $H-H_2$ interactions are measured by simultaneous mass analysis of the atomic particles produced in a single H^0-H_2

collision and recording by the coincidence technique. The energy of the impinging fast hydrogen atoms T_0 was varied between 5 and 50 keV. It is found that the main contribution to slow H_2^+ and H^+ ion formation is by ionization processes, i.e., by processes in which one or two electrons are removed from the target molecule and the charge state of the fast particle (H) remains unchanged. It is found that for ionization and electron capture by the H atom the electron-state populations of the target molecule ($1s\sigma_g$, $2p\sigma_u$, electron-excited state of the H_2^+ ion, and the state formed by two protons $H^+ + H^+$) are practically the same. On the other hand for ionization of molecules with simultaneous stripping of the impinging atom H the population of the upper states ($2p\sigma_u$ and $H^+ + H^+$) is higher. It is found that an appreciable role in dissociation processes of the target molecule is played by direct transfer of kinetic energy to nuclei by the incident particle. This effect is most important in elementary ionization processes involving dissociation in the case of $H^+ - H_2$ and for stripping with ionization and dissociation for $H - H_2$. (auth)

54116 ELECTRON CAPTURE FROM HYDROGEN NEGATIVE IONS BY FAST PROTONS. Janev, R. K. (Inst. of Physics, Belgrade); Salin, A. Fizika (Zagreb); 4: No. 3, 165-72(Jul 1972).

A generalization of the continuum distorted-wave method of Cheshire is made for electron capture in proton-negative-ion collisions. The attractive Coulomb interaction of the partners in the initial state is fully taken into account in this method. For reasons of simplicity of derivations, the generalization is given on the $p + H^-$ system. The cross section for this reaction is calculated in the continuum distorted-wave-Born approximation. (auth)

54117 INELASTIC e-H AND e-He COLLISIONS IN THE ADIABATIC APPROXIMATION. Burnashev, M. A.; Janev, R. K.; Ob'edkov, V. D. (Leningrad State Univ.). Fizika (Zagreb); 4: No. 3, 157-63(Jul 1972).

Using a diagonalized form of the interaction matrix in the electron-atom scattering problem (adiabatic representation), some excitation and spin-change processes are calculated in e-H and e-He collisions. The configuration mixing of the diabatic states, allowing for the correlation effects in the system, is shown to be a significant factor in determining the near-threshold behavior of the inelastic cross section. The calculations demonstrate the superiority of the adiabatic representation with respect to the Born method even in the first order of the theory. The results are compared with more elaborate calculations in the Vainshtein and close-coupling methods as well as with the experimental data. (auth)

54118 EXCITATION IN HEAVY-PARTICLE COLLISIONS. Thomas, E. W. Wiley-Interscience Series in Atomic and Molecular Collisional Processes. New York; John Wiley and Sons, Inc. (1972). 449p. $22.50.

All available data, published between 1945 and Jan. 1, 1970, on the formation of specific excited states of atomic and molecular systems as a result of collisions between atoms, ions, and molecules are tabulated and critically evaluated. Areas included are (1) processes of direct excitation, (2) simultaneous removal of one or more electrons and excitation of an electron that remains bound, (3) transfer of an electron from one of the collision systems into the excited state of the other, and (4) dissociation of molecules giving rise to excited atomic and molecular fragments. Criteria that must be fulfilled in order for an experiment to be considered a valid and accurate measurement are formulated, and experimental techniques are examined in relation to these criteria. The compilation includes a complete bibliography of all work discussed (362 references), an appendix listing data published after Jan. 1, 1970 (89 additional references), a summary index to collisional excitation mechanisms, and tables reproducing the most highly reliable data. (A.G.W.)

54119 MEASUREMENT OF TOTAL CROSS SECTIONS FOR LOW ENERGY POSITRON-HELIUM COLLISIONS. Canter, K. F.; Coleman, P. G.; Griffith, T. C.; Heyland, G. R. (University Coll., London). J. Phys., B (London); 5: No. 8, L167-9(Aug 1972).

An efficient method for the conversion of the high-energy positrons emitted by ^{22}Na into slow positrons of energy about 1 eV was developed using the backscattering of positrons from a gold surface coated with magnesium oxide powder. These positrons were used for the measurement of the total cross section for positron-helium collisions at energies between 2 and 20 eV. A preliminary value for the positron-argon cross section at 8 eV is also given. (auth)

54120 SOME ENERGY CURVES OF ArH^+ AND THEIR USE IN THE STUDY OF THE SCATTERING OF H^+ BY Ar. Sidis, V. (Centre de Mechanique Ondulatoire Appliquee, Paris). J. Phys., B (London); 5: No. 8, 1517-28(Aug 1972).

Calculations on the ground state and some excited states of ArH^+ in the LCAO-STO-MO-SCF approximation are reported. The ground-state interaction potential is then used to study the elastic scattering of protons by argon atoms at low and moderate energies. Partial-wave calculations involving the JWKB evaluation of the phase shifts are compared to the available experimental results and subsequently used to improve the well depth obtained in the ab initio calculation. The values $U = 4.3$ eV and $R_e = 1.34$ Å are thus found. Qualitative discussions of the approximate excited states lead to the conclusions that the excitation of the argon target, at moderate energies, can take place only via the charge-exchange channel. This charge-exchange channel is itself coupled to the ground state at internuclear distances $1.70 \text{ Å} \lesssim R_x \lesssim 1.85 \text{ Å}$. A tentative explanation of the preferential excitation of Ar^* ($3p^5$ 3d) is given. (auth)

54121 ELECTRON LOSS IN ATOM-MOLECULE COLLISIONS. Mathur, K. C.; Tripathi, A. N.; Joshi, S. K. (Univ. of Roorkee, India). J. Phys., B (London); 5: No. 8, 1529-32(Aug 1972).

The cross sections for the electron loss from hydrogen atoms colliding with molecular targets H_2, N_2, and O_2 are calculated using the free collision model of Dmitriev and Nikolaev (Sov. Phys. JEPT, 17: 447(1963)). The molecules are treated under the separated-atom approximation, and the phase difference between the electrons scattered from the two atoms of the molecule is considered. The vibrational motion of the molecule is also accounted for. The results are compared with other calculations and experimental data. (auth)

54122 DIFFERENTIAL MEASUREMENTS ON ION-ATOM COLLISIONS IN THE ENERGY RANGE 500 TO 3000 eV. 4. H^+-NOBLE GAS ATOM COLLISIONS. Abignoli, M.; Barat, M.; Baudon, J.; Fayeton, J.; Houver, J. C. (Centre National de la Recherche Scientifique, Orsay, France). J. Phys., B (London); 5: No. 8, 1533-53(Aug 1972).

Collisions between H^+ and rare gas atoms (He, Ne, Ar, Kr, Xe) were studied in the energy range $0.5 \leq E_0$ (lab) ≤ 3 keV and in the angular range $0.5° \leq \theta \leq 10°$. Differential cross sections were measured for the main collision processes: elastic collision, charge exchange, simple excitation of the atom, and excitation of the atom to autoionizing levels. In most of the cases, the elastic cross sections are in rather good agreement with theoretical semiclassical, or semiquantal, cross sections calculated from ab initio potentials. As the atomic number of the target atom is increased, the charge-exchange probability becomes larger and shows a stronger angular dependence. These features are explained by considering the energy diagrams of the molecular systems, in which the "exchanged" state potential curves become closer to the ground state curve as heavier atoms are taken; in the case of Xe, a pseudocrossing of the two curves occurs and Stueckelberg's interferences are observed in the charge-exchange probability. The excitation process evolves in the same way as the charge exchange, but its threshold in τ is slightly larger. As no excited state (dissociating into H^+ plus the excited atom) interacts with the ground state, the excitation is considered as a two-step process, taking place via charge exchange. The excitation of the target atom to autoionizing levels is qualitatively explained, in the MO model framework, by the promotion of two p electrons and can be considered also as occurring via charge exchange. (auth)

54123 COLLISIONAL IONIZATION OF HELIUM BY SLOW ELECTRONS. Ehrhardt, H.; Hesselbacher, K. H.; Jung, K.; Willmann, K. (Univ. Trier-Kaiserslauter, Ger.). J. Phys., B (London); 5: No. 8, 1559-71(Aug 1972).

For single ionization of helium by electron impact the energies and scattering angles of the scattered and ejected electrons were measured in a coincidence experiment at primary energies E_0 between 30 and 80 eV. Two types of collision are found, those in which the momentum transfer to the ion produced is small (binary encounter) and those in which the momentum transfer is large (recoil encounter). The maximum in the measured coincidence rate due to collisions of the binary-encounter type is located in the forward direction. Its angular position varies with the collision parameters, whereas its angular half width is approximately 60° for all data obtained. The recoil collisions cause a maximum of the coincidence cross section at about 160° with a half width larger than 90°. The relative intensity of the binary-encounter and the recoil peaks as well as the total number of ionizing transitions depends strongly on the energies and angles of the two outgoing electrons. Binary peak and recoil peak do not have a common symmetry axis, probably because of the interaction between the two ionization electrons. (auth)

54124 COVENIENT DETERMINATION OF RESONANCE STATES IN ATOMIC COLLISIONS. Truhlar, Donald G. (Univ.

of Minnesota, Minneapolis). Chem. Phys. Lett.; 15: No. 4, 483-5(1 Sep 1972).

A new method, using the finite-difference boundary-value method, is proposed for finding the wave functions and energies of shape-resonance states in atomic collisions. A numerical illustration is presented for the l = 50 states of OH ($X^2\Pi$). (auth)

54125 TEST OF MASSEY'S METHOD FOR CALCULATING THE STATIC POTENTIAL FOR ELECTRON SCATTERING BY N_2. Truhlar, Donald G. (Univ. of Minnesota, Minneapolis). Chem. Phys. Lett.; 15: No. 4, 486-9(1 Sep 1972).

The method of linear combination of scaled atomic charge distributions, as invented by Massey, is tested for electron scattering by the nitrogen molecule. (auth)

54126 NEAR-RESONANT VIBRATION–ROTATION ENERGY TRANSFER IN ATOM–DIATOM COLLISIONS: Ar–OH($A^2\Sigma^+$). Smith, Wesley D.; Pack, Russell T. (Brigham Young Univ., Provo, Utah). Chem. Phys. Lett.; 15: No. 4, 500-4(1 Sep 1972).

Cross sections and rate constants for the inelastic collision, $OH(A^2\Sigma^+, \nu = 1, j = 15) + Ar \rightarrow OH(A^2\Sigma^+, \nu = 0, j = 20) + Ar$, were calculated in the infinite-order sudden (IOS) and distorted-wave (DW) approximations. The results agree well with experiment. (auth)

54127 THEORETICAL DESCRIPTION OF AN ASYMMETRIC, NONRESONANT CHARGE-TRANSFER PROCESS, $Li + Na^+ \rightleftharpoons Li^+ + Na$: THE TWO-STATE APPROXIMATION. Melius, Carl F.; Goddard III, William A. (California Inst. of Tech., Pasadena). Chem. Phys. Lett.; 15: No. 4, 524-9(1 Sep 1972).

The charge-transfer process for the collision $Li + Na^+ \rightleftharpoons Li^+ + Na$ was studied theoretically by a two-state impact-parameter approach using molecular wave function. By including the Born–Oppenheimer breakdown term $\langle \psi_1 | \partial/\partial R | \psi_2 \rangle$ as the coupling term between states, total charge-transfer cross sections in good agreement with experimental results are obtained. (auth)

54128 DETERMINATION OF OPTICAL SUMS FROM THE SMALL-ANGLE ELECTRON-IMPACT SPECTRA OF ARGON. Wellenstein, H. F.; Bonham, R. A. (Indiana Univ., Bloomington). Chem. Phys. Lett.; 15: No. 4, 530-5(1 Sep 1972).

A method for obtaining optical sums directly from high-energy (25-keV) electron-impact spectra in the forward direction is suggested. The electron energy-loss spectrum of argon at an energy resolution of ±600 meV was obtained for energy losses from zero to 50 eV and 200 to 300 eV at an energy resolution of 5 eV averaged over an angular range of $\pm 5 \times 10^{-4}$ radians. The data were corrected for finite detector size, gas and electron beam spatial distributions to obtain an estimate of the zero-angle scattering spectrum. A hydrogenic contribution was assumed for the 3p, 3s continuum for energy loss greater than 50 eV and for the 2p continuum for energy loss greater than 280 eV. Various moments of the spectrum were computed and related to optical sums by use of the measured experimental moments of the energy distribution of the incident beam and the scale factor needed to place the data on an absolute scale. The scale factor was obtained by use of the Thomas–Reiche–Kuhn sum rule. The results are in excellent agreement with previous estimates of the various sum rules and the present approach shows promise for providing useful data for a large number of atomic and molecular targets. (auth)

54129 THEORY OF SEMICLASSICAL TRANSITION PROBABILITIES FOR INELASTIC AND REACTIVE COLLISIONS. IV. CLASSICALLY-INACCESSIBLE TRANSITIONS CALCULATED BY INTEGRATION ALONG COMPLEX-VALUED TRAJECTORIES. Stine, J.; Marcus, R. A. (Univ. of Illinois, Urbana). Chem. Phys. Lett.; 15: No. 4, 536-44(1 Sep 1972).

Semiclassical S-matrix elements S_{mn} were calculated by numerical integration along complex-valued trajectories, by avoiding (simply) previously reported trajectory divergences. Now, one can numerically calculate even $|S_{mn}| \approx 10^{-11}$ for the Secrest–Johnson system (their lowest $|S_{mn}|^2$), instead of only $|S_{mn}|^2 > 10^{-3}$. Agreement is excellent. (auth)

54130 MEASUREMENTS OF ABSOLUTE INTEGRAL TOTAL CROSS SECTIONS OF He–H_2 AND THE INTERACTION POTENTIAL. Gengenbach, R.; Hahn, Ch. (Univ., Bonn). Chem. Phys. Lett.; 15: No. 4, 604-8(1 Sep 1972).

The integral total collision cross section for He–H_2 was measured with an absolute accuracy of ±1% to ±4% between 0.14 meV and 2.9 eV. The data have been fitted by a spherical symmetric multiparameter Morse-spline-dispersion potential, which agrees well with results of ab initio calculations at short distances. The long range attraction can be described by the theoretical van der Waals constant C_8, if the dipole–quadrupole interaction $-C_8R^{-8}$ with $C_8 = 41$ au is taken into account. The potential has one bound state for every possible isotopic combination. (auth)

54131 VIBRATIONAL EXCITATION OF A DIATOMIC MORSE OSCILLATOR BY IMPULSIVE COLLISION WITH AN ATOM. Eckelt, P.; Korsch, H. J. (Univ., Muenster, Ger.). Chem. Phys. Lett.; 15: No. 4, 586-9(1 Sep 1972).

The vibrational excitation of a diatomic Morse oscillator by collinear collision with a third atom is treated in the quantum-mechanical impulse approximation. A closed analytic expression for the transition probabilities $P_{n'n}$ is derived. Change in $P_{n'n}$ as a function of the kinetic energy and of the energy transfer if one passes over from a harmonic to a Morse oscillator is discussed. Some numerical results are given for the O_2^+–He system. (auth)

54132 INFLUENCE OF ATTRACTIVE FORCES ON THE QUANTUM-MECHANICAL TRANSITION PROBABILITIES FOR ATOM–DIATOMIC OSCILLATOR COLLISIONS. Roberts, R. E. (Indiana Univ., Bloomington); Diestler, D. J. J. Chem. Phys.; 57: No. 7, 2998-3002(1 Oct 1972).

Numerically exact quantum-mechanical transition probabilities for the collinear collision between an atom and a diatomic oscillator interacting via a strongly attractive Morse potential are compared with those obtained in various simple perturbation approximations. It is concluded that many of the improved perturbation approximations that work well for purely repulsive interactions are also quantitatively accurate for Morse interactions having deeply attractive wells. A simple distorted-wave correction factor, derived, for example, via second-order perturbation theory, yields quite accurate transition probabilities, even for very small reduced collision energies ($E_{coll}/D = 0.05$) where attractive forces dominate in determining the dynamics of the collision. Furthermore, when the perturbation limit is no longer applicable, the so-called exponential approximation provides a viable method for calculating both direct and multiquantum transition probabilities. (auth)

54133 QUANTUM MECHANICAL STUDIES OF THE VIBRATIONAL EXCITATION OF H_2 BY Li^+. White, R. Allen; Hayes, Edward F. (Rice Univ., Houston). J. Chem. Phys.; 57: No. 7, 2985-93(1 Oct 1972).

The quantum mechanical equations of motion for the vibrational excitation of an harmonic are solved via the set of coupled Volterra equations describing that motion. Numerical techniques that allow accurate inclusion of closed channels are developed. The equations are solved for an ab initio interaction potential and for a model potential. The ab initio interaction potential gives results in poor agreement with experiments. A comparison with the results of a two-parameter model potential, which can give results close to the experimental results, provides some insight into features of the surface which are important for vibrational excitation. (auth)

54134 TRANSLATIONAL ABSORPTION OF HeH. Ulrich, Bruce T. (Univ. of Texas, Austin); Ford, Lewis; Browne, J. C. J. Chem. Phys.; 57: No. 7, 2906-10(1 Oct 1972).

Calculation of the translational absorption spectrum of a system of a helium atom and a ground-state hydrogen atom is reported. Values of calculated potential curves for the ground state of the molecular system HeH and the dipole moment of the ground molecular state of HeH as a function of internuclear separation are also given. The behavior of the dipole moment is of particular interest as it passes through zero at about $R = 7a_0$. This change of sign follows from and correlates with the known long-range behavior of the dipole moment of this system. (auth)

54135 DISSOCIATIVE ATTACHMENT OF THERMAL ELECTRONS TO N_2O AND SUBSEQUENT ELECTRON DETACHMENT. Warman, J. M.; Fessenden, Richard W.; Bakale, G. (Carnegie-Mellon Univ., Pittsburgh). J. Chem. Phys.; 57: No. 7, 2702-11 (1 Oct 1972).

The attachment of electrons to nitrous oxide was studied, following pulse ionization, by a microwave conductivity technique. For pure N_2O, and N_2O diluted with N_2, extrapolation of the experimentally observed attachment rate constant to zero pressure gives an upper limit of 1×10^{-15} cm^3 molecule$^{-1} \cdot$ s^{-1} for the rate constant for two-body attachment at 298°K. When C_2H_6 or C_3H_8 is used as diluent a higher two-body rate constant of 6×10^{-15} cm^3 molecule$^{-1} \cdot$ s^{-1} is found, which is believed to represent the rate constant of the dissociative attachment reaction $e^- + N_2O \rightarrow N_2 + O^-$. The much lower value for pure N_2O or N_2O–N_2 mixtures is explained by the regeneration of electrons, via the reactions $O^- + N_2O \rightarrow NO + NO^-$ and $NO^- + N_2O \rightarrow NO + N_2O + e^-$, which largely nullifies the primary attachment step. The presence of a hydrocarbon prevents electron regeneration by irreversibly reacting with O^- and allows observation of the uncomplicated rate constant for dissociative attachment. The rate constant for dissociative attachment increases markedly with increasing temperature and in the range studied, 278 to 355°K, has an activation energy of 0.42 ± 0.04 eV. Confirming evidence for the proposed mechanism is obtained from the effect, on the attachment rate constant, of H_2 added

to $C_2H_6-N_2O$ mixtures. The H_2 reacts with O^- by the associative detachment reaction $O^- + H_2 \rightarrow H_2O + e^-$ to nullify the primary attachment step and to reduce the rate constant by an appropriate amount. In the steady-state radiolysis of N_2O, the yields of the products N_2 and NO are found to increase markedly with decreasing pressure below 50 torr. These increases in yields may be quantitatively related to the chain reaction resulting from dissociative attachment followed by electron regeneration. (auth)

54136 DEPENDENCE OF REACTIVITY ON INTERNAL TRANSLATIONAL ENERGY IN K + SF_6, CCl_4, AND $SnCl_4$. Sloane, Thompson M.; Tang, S. Y.; Ross, John (Massachusetts Inst. of Tech., Cambridge). J. Chem. Phys.; 57: No. 7, 2745-55(1 Oct 1972).

The dependences of the nonreactive scattering of potassium atoms at thermal energies from SF_6, CCl_4, and $SnCl_4$ on internal energy of the molecules and initial relative kinetic energy are studied as a function of scattering angle. A collimated, velocity-selected beam of potassium atoms is crossed at right angles with a molecular beam whose source temperature is varied over the range of 300 to 580°K. The angular dependence of the nonreactive cross sections is analyzed with an optical model of chemical reactions to obtain information about potential parameters in an assumed form of two-body interaction, the threshold conditions for reaction, the probability of reaction as a function of the distance of closest approach and internal energy, as well as an estimate of the total reaction cross section. The threshold conditions, energy, and distance in the reaction K + SF_6 are independent of the initial relative kinetic energy at both low and high SF_6 temperatures; the threshold distance increases by about 6% from $T(SF_6)$ = 300°K to 580°K. The variation of the nonreactive scattering with the SF_6 beam source temperature, or SF_6 internal excitation, can best be explained by a model in which only the stretching vibrational modes of SF_6 are assumed to have an effect on the reactivity with K. The calculated differential cross sections based on this model fit very well to the measured results over the experimental ranges of SF_6 temperature and of initial relative kinetic energy (2.05 to 5.18 kcal/mole). The effect of internal energy in CCl_4 on its reactivity with K is similar to that of SF_6 but smaller. The effect in $SnCl_4$ is very small and uncertain; the interpretation is complicated by the lack of knowledge about the interaction potential. (auth)

54137 REACTIONS BETWEEN HYDROCARBON IONS CH_n^+ AND GASEOUS TARGETS, IN THE 40 TO 140 keV ENERGY RANGE. Roussel, M. (CEN, Fontenay-aux-Roses, France). J. Phys. (Paris); No. 4, 321-9(Apr 1972). (In French).

Some products of collisions between CH_n^+ ($0 <= n <= 4$) ions in the 40- to 140-keV energy range and gaseous targets (H_2, N_2, He, Ne, Ar) were studied. The cross sections for the following reactions were measured: charge exchange of C^+ ions, dissociation of CH_n^+ ions through reactions like $CH_n^+ \rightarrow CH_{n-p}^+$, and production of hydrogen atoms in coincidence with hydrocarbon ions through reactions like $CH_n^+ \rightarrow CH_{n-p}^+ + H + \ldots$. (France)

54138 COLLISIONS OF FAST ELECTRONS WITH HELIUM. I. VARIOUS FORMS OF THE SECOND BORN APPROXIMATION. Woollings, M. J.; McDowell, M. R. C. (Royal Holloway Coll., London). J. Phys., B (London); 5: No. 7, 1320-31(Jul 1972).

Various forms of the second Born approximation are applied to electron collisions with helium in the energy range 200 to 500 eV. In each case all intermediate states up to 3^1P are included explicitly, and a closure approximation is used for higher states, the energy parameter being chosen to fit the total cross section and dispersion relation values for Re f(0) and Im f(0). Calculations are carried out with and without V^4 terms and in a 1,1 Padé approximation, for the 1^1S, 2^1S, and 2^1P transitions. Results are compared with experiment and with results of other calculations. The present results cast doubt upon the practice of normalizing experiment to the first Born approximation at intermediate energies. (auth)

54139 ION–ATOM SCATTERING AND INTERATOMIC POTENTIALS FOR IONS OF NOBLE METALS AND PERIOD II ELEMENTS INCIDENT ON NEON AND ARGON WITH ENERGIES IN THE RANGE 8 TO 25 keV. Foster, C.; Wilson, I. H.; Thompson, M. W. (Univ. of Sussex, Brighton, Eng.). J. Phys., B (London); 5: No. 7, 1332-42(Jul 1972).

Information about the potential energy of interaction was obtained for the ions, Na^+, Mg^+, Al^+, P^+, Cl^+, Cu^+, Ag^+, Au^+, Ni^+, and Zr^+, on the inert gases Ar and Ne. The scattering of an ion beam in the energy range 8 to 25 keV by passage through a gas was used to measure incomplete total cross sections against energy curves, from which the parameters K and S in an assumed form for the potential $V(r) = K/r^s$ were determined. Theoretical potentials were compared with those obtained experimentally, and for the range of separation 1.1 Å to 1.6 Å a Moliere-type screened Coulomb potential was found to give good agreement, whereas the Thomas–Fermi potential of Firsov gave poor agreement. The variation of the potential with Z_1 was noted and thought to be a product of detailed atomic structure in a way not predicted by any statistically determined potential. (auth)

54140 INELASTIC PROCESSES IN He^+–He COLLISIONS. Barat, M.; Dhuicq, D.; Francois, R.; (and others) (Paris Univ., Orsay, France). J. Phys., B (London); 5: No. 7, 1343-50(Jul 1972).

Measurements are reported of the differential cross sections for excitation of inelastic processes in He^+–He collisions for the range of incident ion energy from 1 to 3 keV. The use of an improved energy analyzer permits the detection of a number of inelastic channels, hitherto unresolved. In particular, the excitation of He in the (1s2p) $^{1,3}P$ state is well separated from other channels; the reactions for the formation of $He^+(2p)$ and He^{2+} are studied for the first time. The results, which are given for scattering angles θ up to 8° in the laboratory system, confirm that for $E \gtrsim 4$ keV deg, excitation occurs mainly via rotational coupling between the $^2\Sigma_u$ and $^2\pi_u$ states and between the $^2\Sigma_g$, $^2\pi_g$, and $^2\Delta_g$ states of the He_2^+ quasimolecule. As for the measurements of direct ionization, the oscillatory structure observed in the energy distribution of the ejected electrons for a given E is interpreted by a crossing mechanism between the $^2\Sigma_g$ state of He_2^+ and the $^2\Sigma_g$ continuum state of the system (He_2^{2+} + e). (auth)

54141 IONIZATION PROCESSES IN SLOW COLLISIONS OF HEAVY PARTICLES. I. He AND He^+ ON Ne, Ar, Kr, AND Xe. Gerber, G.; Morgenstern, R.; Niehaus, A. (Univ., Freiburg i. B.). J. Phys., B (London); 5: No. 7, 1396-1411(Jul 1972).

Apparatus for the investigation of ionizing collisions of heavy particles by electron spectroscopy is described. Collisions of He^+ and He on Ne, Ar, Kr, and Xe are studied in the kinetic-energy range from 100 to 5000 eV by measurement of energy spectra and angular distributions of the ejected electrons. As in collisions at higher energies, the spectra are composed of discrete peaks arising from autoionizations of the separated particles and a continuous part. This latter part is much more pronounced for collisions with He^+. A mechanism for the production of the continuous part is proposed, which explains this fact. The angular distributions of electrons of discrete energies (peaks) are found to be nonisotropic in some cases and dependent on the collision energy. In one case the distribution is asymmetric with respect to $\theta = \pi/2$ (angle measured from beam direction). (auth)

54142 ELASTIC SCATTERING OF 5 TO 90 eV NEUTRAL GOLD ATOMS BY ARGON. Foster, C.; Wilson, I. H.; Thompson, M. W. (Univ. of Sussex, Brighton, Eng.). J. Phys., B (London); 5: No. 7, L140-2(Jul 1972).

The velocity dependence of the total elastic cross section for 5- to 90-eV gold neutrals on Ar was measured. Information about the interaction potential was obtained, which shows evidence of a Lennard-Jones type of behavior. A similarity of the Cs–Ar case is noted. (auth)

Atomic Theory

Refer also to abstracts 54374, 54382, and 55077.

54143 OPTIMIZATION OF THE TRANSFERABILITY OF ATOMIC HARTREE–FOCK VALENCE-SHELL ORBITALS. Adams, William H. (Rutgers–The State Univ., New Brunswick, N. J.). J. Chem. Phys.; 57: No. 6, 2340-3(15 Sep 1972).

Two procedures by which atomic valence-shell orbitals may be transferred between atoms were studied numerically. The one procedure optimizes the overlap between transferred and true orbitals, and the second optimizes the electronic energy calculated with the transferred orbitals. The two procedures give significantly different results. Both improve on the results obtained in a previous study. (auth)

54144 ATOMS IN INTENSE MAGNETIC FIELDS AND AN ATTRACTIVE ALTERNATIVE TO THE THOMAS–FERMI MODEL OF ATOMS. Mueller, Ronald Otto. New York; New York Univ. (1972). 126p. University Microfilms Order No. 72-21,526.

Thesis.

The enormous magnetic fields ($B \sim 10^{12}$ gauss) that presumably exist on pulsars can greatly change the structure of atoms. The motion of all electrons in the plane perpendicular to the magnetic field is assumed fixed by the magnetic field (adiabatic approximation). The response of the electrons to the Coulomb attraction is essentially restricted to a one-dimensional motion parallel to the field. Two regimes of field strength are distinguished. For $Z^4 \ll 10^{-9}B \ll 10Z^3$ gauss a variationally formulated "one-dimensional" Thomas–Fermi-like model is valid for heavy atoms. The dimen-

sions of the atom are greatly reduced and the total ground-state binding energies greatly increased from the no-B field situation. Surprisingly, the overall electronic number density, n(r), retains spherical symmetry (even though the number density of each electron is strongly asymmetrical). The choice $n(r) \propto ZR^{-3}\,\sigma - 1/4 \exp(-\sigma)$, $\sigma = r^2/R^2$, gives $E \cong -150(B/10^{12})^{2/5}Z^{9/5}$ eV for neutral atoms. For $B \gg 10^{10}Z^3$ gauss a crude variational calculation for the energy (applicable for heavy atoms) indicates that the electronic number density is strongly elongated along the field direction and gives for the ground-state binding energy $E \simeq -13.6N(Z - N/3)^2\ln^2(2B/10^{10})$ eV (nuclear charge Z, N electrons). The binding and ionization energies of a few very light atoms and ions of astrophysical interest (He, H^-) are also presented. The Thomas–Fermi-like method is extended to "crushed" atoms (that is, atoms restricted to volumes much less than their normal volumes by the pressure of neighboring atoms) in the outermost layers of the pulsar crust. The resulting pressure–density equation of state changes the thickness of these layers (with $\rho \lesssim 10^4$g cm^{-3}) from the no-B field situation and, further results in a much higher value for the density that marks the surface of the star. These results may be of interest for calculations of opacity coefficients and other properties associated with the outer reaches of the pulsar. In a separate consideration, a simple atomic model, which physically is far more realistic than the normal Thomas–Fermi model (B = 0), is developed. In particular, it improves upon the description of regions close to and far away from the nucleus (regions where there is a breakdown of the assumptions of the Thomas–Fermi method). Furthermore, it applies equally to atoms of small as well as large atomic number as opposed to the Thomas–Fermi method, which is a statistical model. Placing the electrons in hydrogen-like states with different nuclear charge (always maintaining orthogonality of the set of single particle states) chosen to satisfy the Pauli principle, a variational upper bound for the energy is obtained, which is more accurate than Thomas–Fermi. Moreover, calculations reduce to simple algebra and can be improved by the inclusion of more variational parameters (the different nuclear charges serve as variational parameters). The resulting charge density and effective Coulomb potential are analytic and when used in the calculation of other atomic properties yield the usual "Thomas–Fermi scaling laws." Some aspects of shell structure are also inculded; for example, the model gives reasonable estimates of the ionization energy of the last electron. (Diss. Abstr. Int., B)

54145 INTEGRAL-EQUATION APPROACH TO BOUND-STATE ATOMIC SYSTEMS: PRELIMINARY STUDIES OF HELIUM AND HYDROGEN. Cooper, W. Grant; Kouri, Donald J. (Univ. of Houston, Tex.). J. Chem. Phys.; 57: No. 6, 2487-97(15 Sep 1972).

The Sams–Kouri method for noniteratively solving integral equations is used to solve the integral form of Schrödinger's equation for He such that the Hartree–Fock approximation is avoided and the inclusion of nuclear motion is straightforward. An exact formalism is presented, which requires the solution to coupled integral equations, and the method for generalizing to many-electron atoms is indicated. Calculations are reported for a single integral equation approximation to He, which illustrates the essential features of the method. The energy value obtained is approximately 85% of the total binding energy. Calculations for the H atom are given so comparisons with an exactly soluble atomic problem can be made, and the energy values for the ground and first three excited states are in excellent agreement with the exact values. Excited-state calculations are found to be no more difficult than those for the ground state. (auth)

54146 PROBABILISTIC INTERPRETATION OF CLUSTER FUNCTION SERIES DEVELOPMENT OF MANY-ELECTRON WAVE FUNCTIONS. Hertia, D. I.; Ivanov, Al. (Inst. of Physical Chemistry, Bucharest). J. Chem. Phys.; 57: No. 6, 2581-5 (15 Sep 1972).

A probabilistic treatment of the polyfermionic systems is made. The idea of localizability of the particles on bounded sets in the X-configuration space of the system is used. The decomposition of this space into a union of bounded sets permits a natural decomposition of the wave function into a cluster function series. A physical interpretation of this type of expansion and the establishment of a definition for the correlation phenomenon independently of a Hartree–Fock or other particular model are discussed. (auth)

54147 RELATIVISTIC CORRECTIONS IN HEAVY ATOMS. Braun, M. A.; Sibirkina, T. N. Vestn. Leningrad. Univ., No. 22, Fiz., Khim.; No. 4, 13-22(Nov 1971). (In Russian).

A method has been proposed for the construction of the Hamiltonian that describes the interacting atomic electrons for $Z\alpha \sim 1$. The method uses the Furry representation. The two- and three-body interaction potentials are found up to order α^3. The expression for the electron energy shift due to the three-body potentials is obtained. A simplified calculation of the relativistic corrections for the K electrons is discussed, which neglects their relativistic and exchange interactions with other electrons. (auth)

54148 MANY-PARTICLE CORRELATION FOR MANY-ELECTRON SYSTEMS IN DIFFERENT ORDERS OF PERTURBATION THEORY. Zashikhin, M. N. Vestn. Leningrad. Univ., No. 22, Fiz., Khim.; No. 4, 23-8(Nov 1971). (In Russian).

Many-particle equations, which generalize the two-particle equations of Fock–Veselov, and Petrashen, were studied. The cluster expansion for the energy of a many-electron system is obtained in any order of the perturbation theory. (auth)

54149 Z-EXPANSION COEFFICIENTS AND THE NUMBER OF ELECTRONS. Synder, R. (Queen's Univ., Belfast). J. Phys., B (London); 5: No. 8, L147-50(Aug 1972).

It is shown that in a closed-shell atom with a large number of electrons, N, the zero- and first-order Z-expansion coefficients are given approximately by $E_0(N) \simeq -\beta N^{4/3} + 1/2 - 1/18\,\beta^{-2}N^{-4/3}$ and by $E_1(N) \simeq 1/2\,\beta N^{1/3}$, where $\beta = (3/2)^{1/3}$. (auth)

54150 PROPERTIES AND USES OF NATURAL ORBITALS. Davidson, Ernest R. (Univ. of Washington, Seattle). Rev. Mod. Phys.; 44: No. 3, 451-64(Jul 1872).

Natural orbitals are a particularly efficient choice of single-particle states for use in construction of electronic wave functions. This review discusses the general properties of the natural orbitals. Natural orbitals are compared to Hartree–Fock orbitals and relative merits are presented. Methods of determining and using natural orbitals in construction of electronic wave functions are presented. (94 references) (auth)

54151 ATOMIC STRUCTURE OSCILLATION EFFECTS. Kirzhnits, D. A.; Shpatakovskaya, G. V. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz.; 62: No. 6, 2082-96 (Jun 1972). (In Russian).

An expression for the oscillation corrections to the Thomas–Fermi model is obtained within the framework of the quasi-classical approximation. The expression permits one to describe averaged characteristics of the physical system as well as irregularities related to the shell structure. Spatial oscillations of the electron density of a heavy atom can be described with an accuracy of about 5%. (auth)

54152 TWO PERTURBATIONS IN THE PRESENCE OF DEGENERACY. Chisholm, C. D. H.; Lodge, K. B. (Univ. of Sheffield, Eng.). Chem. Phys. Lett.; 15: No. 4, 571-4(1 Sep 1972).

The second-order energy in Rayleigh–Schrödinger single perturbation theory for a degenerate level with two perturbations is written in "double perturbation" form. The difficulties in formal double perturbation theory are avoided. (auth)

54153 ASYMPTOTIC BEHAVIOR OF ATOMIC-BOUND-STATE WAVE FUNCTIONS. Ahlrichs, Reinhart (Univ., Karlsruhe, Ger.). Chem. Phys. Lett.; 15: No. 4, 609-12(1 Sep 1972).

An upper bound is derived for $||r_i^{\mu}\varphi||$, $\mu = 1,2,\ldots$, where φ denotes an atomic bound-state eigenfunction and r_i is the distance of the ith electron from the nucleus. It is then shown that φ vanishes exponentially if any of the r_i approaches infinity. (auth)

54154 MANY-ELECTRON WAVE FUNCTIONS EXPANDED IN SPIN-ADAPTED ANTISYMMETRIZED PRODUCTS, AND THEIR EXPECTATION VALUES. Salmon, William I.; Ruedenberg, Klaus (Iowa State Univ, Ames). J. Chem. Phys.; 57: No. 7, 2776-86(1 Oct 1972).

Unrestricted configuration-interaction wave functions are constructed according to certain conventions that simplify the calculation of expectation values when S is a good quantum number. General wave functions are expressed in terms of antisymmetric space-spin functions that are eigenstates of S^2 and S_z, and form a complete orthonormal set. The building blocks, called "spin-adapted antisymmetrized products" or SAAP's, are designed to take advantage of double occupancy. It is shown that SAAP's, when constructed from orthonormal space orbitals, can be handled in multiconfigurational calculations more easily than Slater determinants. Simple formulas are derived for matrix elements of observable operators expressible in terms of one- and two-electron integrals. (auth)

54155 IMPLEMENTING THE SAAP FORMALISM. I. SERBER-TYPE SPIN EIGENFUNCTIONS BY DIRECT DIAGONALIZATION. Salmon, W. I.; Ruedenberg, K.; Cheung, L. M. (Iowa State Univ., Ames). J. Chem. Phys.; 57: No. 7, 2787-90(1 Oct 1972).

A method is given for generating Serber-type spin eigenfunctions for use in expansions of general electronic wave functions in terms of spin-adapted antisymmetrized products (SAAP's). The procedure is efficient and avoids the large storage requirements of spin-coupling schemes using Wigner coefficients. Running times of computer programs are given. (auth)

54156 IMPLEMENTING THE SAAP FORMALISM. II. SIMULTANEOUS EIGENFUNCTIONS OF L^2 AND S^2 BY DIRECT DIAGONALIZATION. Salmon, W. I.; Ruedenberg, Klaus (Iowa State Univ., Ames). J. Chem. Phys.; 57: No. 7, 2791-3(1 Oct 1972).

A procedure is described for generating simultaneous atomic eigenfunctions of S^2, S_z, L^2, and L_z as linear combinations of spin-adapted antisymmetrized products of atomic orbitals. The resulting functions are of the Serber type, i.e., they also are eigenfunctions of all geminal pair-spin operators. Flow diagrams for computer programs are given and running times are quoted. (auth)

54157 COMPLEX AND UNRESTRICTED HARTREE–FOCK WAVE FUNCTIONS. Ostlund, Neil S. (Univ. of Arkansas, Fayetteville). J. Chem. Phys.; 57: No. 7, 2994-7(1 Oct 1972).

The general conditions under which real, restricted Hartree–Fock wave functions become unstable with respect to variation of the orbitals are derived. It is shown that complex solutions to the Hartree–Fock equations are associated with a singlet instability in the usual real restricted solution. A comment is made concerning the complex wave functions found by Harris and Pohl for hydrogen halides at short internuclear distances. (auth)

PHYSICS (ELECTROFLUID AND MAGNETOFLUID)

54158 MAGNETOHYDRODYNAMIC FLOW NEAR A TIME-VARYING ACCELERATED PLATE. Mohapatra, Priti (Utkal Univ., Bhubaneswar, India). Indian J. Phys.; 45: No. 9, 421-31(Sep 1971).

The flow of an electrically conducting incompressible viscous liquid due to the time-varying motion of an infinite flat plate is studied in the presence of a uniform magnetic field. The magnetic lines of force are taken to be fixed relative to the fluid. General expressions of the velocity and skin friction are obtained when the plate moves with the velocity $e^{at}t^n$. Several particular cases are studied, and the results are compared with the aid of some graphs and tables. (auth)

54159 REFLECTION OF A HYDROMAGNETIC SHOCK WAVE FROM A BOUNDARY SHOCK. Verma, B. G.; Prasad, Baleshwar (Univ. of Gorakhpur, India). Indian J. Phys.; 45: No. 10, 439-42(Oct 1971).

After consideration of the earlier works on boundary shock waves in a gas, under viscous stress and magnetic pressure, the Hugoniot relation is used and a linear relationship is obtained between reflected velocity, magnetic field, and viscous compressive stress. (auth)

54160 THEORETICAL STUDY OF THE ELECTROMAGNETIC COUPLING (IN THE FORCED OSCILLATION REGION) OF TWO ONE-DIMENSIONAL LAMINAR FLOWS OF A VISCOUS ELECTRICALLY CONDUCTING LIQUID IN THE PRESENCE OF A UNIFORM TRANSVERSE ELECTROMAGNETIC FIELD. Dorlhac, Francois (College Scientifique Universitaire, Avignon, France). Compt. Rend., Ser. A; 274: No. 22, 1586-9 (29 May 1972). (In French).

The electromagnetic coupling (in the forced oscillation region) of two one-dimensional flows was studied. The two hydraulically independent flows are in perfect electrical contact at infinity in a direction perpendicular to the flow and to the magnetic field. Phase shift curves and curves representing the variations in the coefficient of performance are presented as functions of the pulsation and the magnetic field. (France)

54161 THEORETICAL STUDY OF THE FLOW OF AN ELECTRICALLY CONDUCTING VISCOUS LIQUID, AGITATED BY AN OSCILLATING PLANE, IN A MAGNETIC INDUCTION FIELD. Poirier, Yves (Centre Universitaire, Saint-Denis, France). Compt. Rend., Ser. A; 274: No. 21, 1514-16(24 May 1972). (In French).

A theoretical study of the viscous flow of an electrically conducting liquid between a fixed plane and an oscillating parallel plane is presented. A uniform magnetic induction is assumed to be applied in a direction normal to the planes limiting the flow. Curves illustrating the variations in the amplitude of the mean velocity of the liquid and its phase shift with respect to the motion of the oscillating plane are presented. (France)

PHYSICS (HIGH-ENERGY)

Particle Interactions and Properties (Experimental)

54162 (ISS–71/31) SEMINAR AT THE PHYSICS LABORATORY DURING THE PERIOD JULY–DECEMBER 1970. (Istituto Superiore di Sanita, Rome (Italy). Laboratori di Fisica). 10 Nov 1971. 22p. (In Italian and English). Dep. NTIS (U. S. Sales Only).

This report presents a synopsis of the lectures held at the Physics Laboratory of the Istituto Superiore di Sanita during the period July–December 1970. (auth)

54163 (NP–19421) HIGH ENERGY MEASUREMENTS OF TOTAL CROSS SECTIONS ON PROTON, DETECTING VERY LOW ENERGY NEUTRONS. Note No. 370. D'Angelo, S.; Monacelli, P.; Sebastiani, F. (Rome Univ. (Italy). Istituto di Fisica. Istituto Nazionale di Fisica Nucleare, Rome (Italy)). 7 Apr 1972. 4p. Dep. NTIS (U. S. Sales Only).

It is pointed out that the total cross sections for particle interactions with protons at high energies and momentum transfers may be measured using a deuterium target and detecting very low energy spectator neutrons. (J.F.P.)

54164 SEARCH FOR $^1/_3$e AND $^2/_3$e CHARGED QUARKS IN THE COSMIC RADIATION AT 2750-m ATTITUDE. Cox, A. J.; Beauchamp, W. T.; Bowen, T.; Kalbach, R. M. (Univ. of Arizona, Tucson). Phys. Rev., D; 6: No. 5, 1203-11(1 Sep 1972).

A scintillation counter telescope consisting of eight liquid scintillation counters and four wide-gap spark chambers was used to search for particles with electric charge $^1/_3$e and $^2/_3$e in cosmic rays at 2750 m above sea level. No such particles were detected during the 1500-h experimental run, establishing upper limits on the vertical fluxes of 8.3×10^{-11} cm^{-2} sec^{-1} sr^{-1} and 9.6×10^{-11} cm^{-2} sec^{-1} sr^{-1} for charge $^1/_3$e and $^2/_3$e, respectively. Estimates of the corresponding sea-level fluxes are made for comparison with previous results. (auth)

54165 SEARCH FOR QUARKS AT THE 70 GeV ACCELERATOR. Zaitsev, A. M.; Landsberg, L. G. (Inst. of High Energy Physics, Moscow). Yadern. Fiz.; 15: No. 6, 1184-98(Jun 1972). (In Russian).

An analysis and comparison of the results of various experiments on search for quarks, made at the accelerators and in cosmic rays are presented. The model of phase volumes and the phenomenological model, that takes into account the basic peculiarities of heavy particle production in strong interactions were used in calculating the quark spectrum. It is shown that the previous IHEP results are of higher sensitivity for the wide mass range $M_Q = 2 \div 7$ GeV/c^2. (auth)

Electromagnetic

Refer also to abstract 53279.

54166 (CALT–68-322) NEW EVIDENCE ON THE PHOTOEXCITATION OF I = $^1/_2$ NUCLEON ISOBARS. Heusch, C. A.; McNeely, W. A.; Winstein, B. D.; Yellin, S. J. (California Inst. of Tech., Pasadena). Aug 1971. 14p. (CONF-710816-24). Dep. NTIS.

From International symposium on electron and photon interactions at high energies; Ithaca, N. Y. (23 Aug 1971).

The reaction $\gamma + N \rightarrow N^*, N^* \rightarrow N + \eta^0$ is studied. The transition amplitudes and cross sections for $\gamma + p$ and $\gamma + n$ interactions at threshold to 1.1 GeV are found. (J.F.P.)

54167 (COO–3069-71) POLARIZATION OF THE RECOIL PROTON IN THE REACTIONS $\gamma p \rightarrow \pi^0 p$ AND $\gamma p \rightarrow \gamma p$. Technical Report No. 92. Deutsch, M.; Golub, L.; Kijewski, P.; Potter, D.; Quinn, D.; Rutherfoord, J. (Massachusetts Inst. of Tech., Cambridge. Lab. for Nuclear Science). 1972. Contract AT(11-1)-3069. 40p. (DSR–77907-D). Dep. NTIS.

The polarization of the recoil proton in the reaction $\gamma + p \rightarrow \pi^0 p$ was measured. The range $t = -.2$ (GeV/c)^2 to $t = -.65$ (GeV/c)^2 with a bremsstrahlung beam that extends from 3 to 7 GeV. Showers from the π^0 decay are detected with a lead converter, scintillation counter hodoscope, and lead glass counter. Protons are detected by means of counters and wire spark chambers. A sandwich of 10 carbon plates and wire chambers serves as an analyzer. There were 8800 π^0 events selected from a sample of $1.2 \cdot 10^6$ triggers. The polarization is 0 at $t = -.2$ (GeV/c)^2 and decreases to -1 at $t = -.45$ (GeV/c)^2. Since the target asymmetry is expected to be about the same as the recoil proton polarization, the results can be compared with a target asymmetry measurement done at Daresbury. Also the polarization of the proton was examined in the reaction $\gamma + p \rightarrow \gamma + p$ over the same t range. With a total of 3200 events the average polarization is found to be $12 \pm .06$. (auth)

54168 (DESY-72/38) SEPARATION OF σ_1 AND σ_t AT $q^2 \sim 1$ (GeV/c)^2 IN THE RESONANCE REGION. Alder, J. C.; Brasse, F. W.; Chazelas, E.; (and others) (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Jul 1972. 12p. Dep. NTIS (U. S. Sales Only).

Some new values of $R = \sigma_l/\sigma_t$ taken in the resonance region from inelastic e-p-scattering at DESY are reported. Cross sections were measured at $\theta = 57°$ and $\theta = 15$ to $17°$ at $q^2 = 1$ GeV^2. R was calculated at masses $1495 \leq W \leq 1715$ MeV. It was found that the contribution of σ_l to the total cross section is small, below 20%. The errors are less than $\Delta R = 16\%$. (auth)

54169 (JINR–E1-6647) e – d SCATTERING AND NEUTRON FORM FACTORS. Bilen'kaya, S. I.; Kazarinov, Yu. M.; Lapidus, L. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1972. 8p. Dep. NTIS (U. S. Sales Only).

All the available data on the elastic e–d cross section in the squared momentum transfer range 0.3 F$^{-2} \leq q^2 \leq 34.1$ F^{-2} were analyzed. It is shown that a statistically satisfactory fit to all data is impossible without renormalization. The neutron magnetic form factor is in agreement with the scaling law. The systematic errors in normalization of experimental data do not allow one to draw definite conclusions on the value of the neutron electric form factor. (auth)

54170 (LAL–1255) ANALYSIS OF FORM FACTORS IN $K^+ \rightarrow \pi^0\mu^+\nu$ AND $K^+ \rightarrow \pi^0 e^+\nu$ DECAYS. Le Dong (Paris Univ., Orsay (France). Faculte des Sciences). Dec 1971. 194p. (In French). Dep. NTIS (U.S. Sales Only).

Thesis.

In the framework of the X2 program carried out with the heavy liquid bubble chamber of CERN, the following semilepton three-body decays were studied: $K^+ \rightarrow \pi^0 + \mu^+ + \nu$ $K_{\mu 3}$ and $K^+ \rightarrow \pi^0 + e^+ + \nu$ K_{e3}. The interaction may be described in terms of 2 factors having the following forms: $f_+(q^2)$ and $f_-(q^2)$. The ratio $xi = f_-/f_+$ was determined using the two following methods: measurement of the $K^+_{\mu 0}/K^+_{e3}$ branching ratio; analysis of the population density of the Dalitz diagram of the $K^+_{\mu 3}$ decay. The methods used are described. These results are compared with results obtained using other methods. The results are discussed in view of various theoretical predictions. (France)

54171 (LNF–72/31) ANALYSIS OF THE REACTION $\gamma + n \rightarrow p + \pi^-$ IN THE FIRST AND SECOND RESONANCE REGION. Carbonara, F.; Gialanella, G.; Lodi-Rizzini, E.; (and others) (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). 5 Apr 1972. 33p. Dep. NTIS (U.S. Sales Only).

The results of an experimental investigation of the reaction $\gamma + n \rightarrow p + \pi^-$ up to 1 GeV with a deuterium bubble chamber at the Frascati Electron Synchrotron are reported. The experimental procedure is briefly described, and the problem of the use of the deuteron as a target is considered in detail. Total and differential cross sections, derived by using the spectator model, are presented. The results are discussed with respect to possible T violation and isotensor current contribution, a phenomenological fit to the differential cross sections, and photoproduction of the P_{11} (1470) resonance. (17 figures, 6 tables, 31 references) (R.W.R.)

54172 (NP-19415) PHOTOPRODUCTION OF π^+-MESONS ON POLARIZED PROTONS AT PHOTON ENERGIES BETWEEN 0.5 AND 2.2 GeV. Althoff, K. H.; Feller, P.; Herr, H.; Hoffmann, W.; Kadansky, V.; Menze, D.; Opara, U.; Schittko, F. J.; Schulz, W.; Schwille, W. J. (Bonn Univ. (West Germany). Physikalisches Institut). Aug 1972. 15p. (PIB-1-181). Dep. NTIS (U. S. Sales Only).

The target asymmetry $T = (\sigma\uparrow - \sigma\downarrow)/(\sigma\uparrow + \sigma\downarrow)$ for the reaction $\gamma p \rightarrow \pi^+ n$ was measured at the Bonn 2.5-GeV electron synchrotron for a pion CM angle of 40° and γ-energies between 0.5 and 2.2 GeV. Butanol was used as target material. About 35% of the protons could be polarized using the dynamic polarization method in a continuous flow cryostat operating at 1°K and 25 kG. The π^+-mesons were detected in a magnetic spectrometer system. A considerable structure of the asymmetry was observed. (auth)

54173 (RPP/H-97) LEPTON HADRON INTERACTIONS. Toner, W. T. (Rutherford High Energy Lab., Chilton (England)). Aug 1972. 52p. Dep. NTIS (U. S. Sales Only).

It is stated that all recent data on lepton hadron scattering at high energy are inelastic electron scattering data. A review is presented of data from experiments in which only the scattered electron is detected (the so-called single-arm experiments); and from experiments in which one or more of the hadrons produced in the interactions are detected in coincidence with the scattered electrons (the coincidence experiments). The subjects covered are single-arm kinematics; determination of R (where $R = \sigma_L/\sigma_T$, σ_L and σ_T being cross sections for the absorption of longitudinal and transverse virtual photons); scaling at high q^2, sum rules in the Bjorken limit; scaling at low q^2; scattering from deuterons; scattering from complex nuclei; kinematics and general features of coincidence measurements; single π^+ electroproduction; miscellaneous two-body reactions ($\pi\Delta$ channels, KΛ and KΣ, backwards mesons); diffractive electroproduction of vector mesons. (U.K.)

54174 (RPP/H-99) MEASUREMENT OF THE Ξ HYPERON LIFETIMES AND α PARAMETERS. Mayeur, C.; Van Binst, P.; Wilquet, G.; (and others) (Rutherford High Energy Lab., Chilton (England)). 1972. 23p. Dep. NTIS (U.S. Sales Only).

In an experiment using a heavy liquid bubble chamber the the Ξ hyperon lifetimes and α parameters were measured to be $\tau^0_\Xi = (3.04 \pm {}^{0.24}_{0.22}) \times 10^{-10}$ sec, $\tau_\Xi = (1.73 \pm {}^{0.08}_{0.07}) \times 10^{-10}$ sec, $\alpha^0_\Xi = -0.84 \pm 0.27$ and $\alpha_\Xi = -0.42 \pm 0.11$. These values agree with measurements which employed different techniques and are consistent with the predictions of the $\Delta I = 1/2$ rule. (auth)

54175 (SLAC-143) STUDY OF NON-STRANGE BOSON RESONANCES PRODUCED BY QUASI-MONOCHROMATIC PHOTON BEAMS OF ENERGIES BETWEEN 4.3 AND 7.5 GeV IN A HYDROGEN BUBBLE CHAMBER. Menke, Michael M. (Stanford Linear Accelerator Center, Calif.). Dec 1971. Contract AT(04-3)-515. 186p. Dep. NTIS.

The photoproduction of resonances was studied in three exposures of a hydrogen bubble chamber to positron annihilation radiation of 4.3, 5.25 and 7.5 GeV nominal energies. The general analysis procedure and results on the three-prong event topology are presented. The highly constrained reaction $\gamma p \to p\pi^+\pi^-$ was studied over the energy range 2 to 8 GeV, and the reactions $\gamma p \to p\pi^+\pi^-\pi^0$ and $\gamma p \to \pi^+\pi^+\pi^-$n were studied at the annihilation energies. Cross sections are given. Using various models to parameterize ρ^0 photoproduction in $\gamma p \to p\pi^+\pi^-$, the mean t-slope found is 7.0 ± 0.4 GeV^{-2}, while the ρ^0 forward cross section decreases from about 130 μb/GeV^2 at 3.3 GeV to about 100 μb/GeV^2 at 7.5 GeV. The cross section for $\gamma p \to \omega p$ is decomposed into an OPE and a diffractive part, which is found to be 1.5 ± 0.3 μb. $(d\sigma(\rho)/dt)/(d\sigma(\omega)/dt)|_{t=0}$ is then 9.4 ± 2.3 at 7.5 GeV. In comparing $d\sigma/dt$ for vector meson production with that of Compton scattering via VDM for photon energies above 4 GeV, it is found that for $\gamma_\rho^2/4\pi = 0.32 \pm 0.03$ there is good agreement at all s and t. This same value of $\gamma_\rho^2/4\pi$ relates the forward ρ^0 cross sections to $\sigma_T(\gamma p)$ at all our energies. A search for $\rho' \to 2\pi$ finds, at the 90% confidence level, $\rho_{\rho'(1250)} < 0.3$ μb and $\sigma_{\rho'(1650)} < 0.1$ μb per 100 MeV width. Inelastic peripheral ρ^0 production is seen in both the proton and the neutron channels, but with present statistics specific nucleon isobars cannot be associated with it. The quasi-two body reactions $\gamma p \to \pi^-\Delta^{++}$, $\rho^-\Delta^{++}$, and A_2^+ n are observed, with cross sections decreasing with photon energy like E_γ^{-a}. For the first two $a = 1.74 \pm 0.16$ and 0.6 ± 0.2 respectively, indicating that they are unlikely to have the same production mechanism. It follows that if the reaction $\gamma p \to \rho^-\Delta^{++}$ is due to an OPE process, the required rho radiative decay width (~0.5 MeV) is much in excess of the value predicted by SU(3). (auth)

54176 (SLAC-PUB-1043) e^+e^- ANNIHILATION TO HADRONS. Ritson, D. M. (Stanford Linear Accelerator Center, Calif.). May 1972. 27p. (CONF-720409-14). Dep. NTIS.

From third international conference on experimental meson spectroscopy; Philadelphia, PA. (28 Apr 1972).

The discussion of $e^+ + e^-$ annihilation to hadrons covers the information at higher energy which is available and which is expected in the next few years: The total cross sections for hadron production, SU(3) ratios for two-body final states, SU(6) quark model predictions for quasi-two-body particle production, multiplicities and transverse momentum distributions, the production and observation of new resonances, and γ-γ processes. (J.F.P.)

54177 SEARCH FOR 1/3e CHARGED DIQUARKS IN THE COSMIC RADIATION AT 2750-m ALTITUDE. Beauchamp, W. T.; Bowen, T.; Cox, A. J.; Kalbach, R. M. (Univ. of Arizona, Tucson). Phys. Rev., D; 6: No. 5, 1211-17(1 Sep 1972).

A large-area 3.35-m^2 scintillation-counter telescope consisting of eight scintillation counters and four wide-gap spark chambers was arranged to detect single particles with charges $\pm 4/3$ e which might be present in the cosmic radiation at 2750 m above sea level. The upper limit for the vertical flux of such particles is found to be 4.1×10^{-10} cm^{-2} sr^{-1} sec^{-1}. Estimates of the corresponding sea-level flux are made for comparison with previous results. (auth)

54178 MEASUREMENTS OF INCLUSIVE HADRON MOMENTUM DISTRIBUTIONS IN DEEP INELASTIC ELECTROPRODUCTION. Alder, J. C.; Brasse, F. W.; Chazelas, E.; (and others) (DESY, Hamburg). Nucl. Phys.; B46: No. 2, 415-28(1972).

In the deep inelastic region of electron scattering the distribution of hadrons in the direction of the virtual photon was investigated. At $q^2 = 1.16$ GeV^2 and W = 2.63 GeV coincidence measurements between the scattered electron and proton, $\pi^\pm$ and $K^\pm$ were made. Momentum and missing mass distributions are presented. They are compared with other electroproduction measurements, with photoproduction, and with hadronic reactions. (auth)

54179 PHOTOPRODUCTION OF π^- FROM DEUTERIUM AT LABORATORY ENERGIES 600 TO 1250 MeV AND C. M. π PRODUCTION ANGLES 6 TO 160°. Walden, Patrick Lorne. Pasadena, Calif.; California Inst. of Tech. (1972). 237 p. University Microfilms Order No. 72-22,563.

Thesis.

The differential cross sections for reaction $\gamma + n \to \pi^- + p$ were measured for laboratory photon energies between 600 and 1250 MeV, using a liquid deuterium target. The measurements were made using a magnetic spectrometer and a recoil counter in which π's and p's were detected in various combinations. Measurements of the π^- counting rate, the π^-/π^+ counting rate ratio, and the π^-, p coincidence counting rate were used to calculate three independent values for the π^- photoproduction cross section. The cross sections from the latter two measurements were less sensitive to deuterium effects and were averaged to form the set of final data. The most notable feature of the data is the absence of an enhancement near the $F_{15}(1688)$ resonance. This feature was predicted from quark model calculations. The $D_{13}(1520)$ resonance appears to be excited by a helicity 3/2 amplitude as was the case in π^+ photoproduction. (Diss. Abstr. Int., B)

54180 PROTON COMPTON EFFECT IN THE REGION OF THE $\Delta(1236)$-RESONANCE. Genzel, H.; Jung, M.; Rausch, K. R.; Wedemeyer, R.; Weyer, H. J. (Univ., Bonn). Lett. Nuovo Cim.; 4: No. 14, 695-8(5 Aug 1972).

A new measurement of differential cross sections for elastic photon–proton scattering in the region of the first πN resonance is reported. The numerical values are tabulated. The excitation curves illustrate a resonance-like behavior as it is known from π photoproduction. At all angles the cross-section maximum appears at about 320 MeV. The partial width $\Gamma_{\gamma\gamma}$ of the Δ resonance is found to be in good agreement with results from pion photoproduction. (L.B.S.)

Weak

54181 (BNL-16977) FORWARD MUONS AND MUON PAIRS AT ISABELLE. Smith, A. J. S.; Strovink, Mark (Brookhaven National Lab., Upton, N. Y.). 16 Jun 1972. 8p. Dep. NTIS.

Some of the processes possibly giving rise to muons and muon pairs produced at ISABELLE along the beam directions are mentioned, and the problems associated with their detection are considered. To be specific, attention is focussed on muons which intersect the spectrometer. At one end of the 20 m "west" straight section, five magnetized iron toroids of 4 m diameter and 1 m thickness are distributed along the beam. Detectors in the 0.5 m interstices measure both position and angle of the muon trajectory. Nearly the full azimuthal range is accepted between polar angles of 50 and 400 mrad. Additional details appear in section C below. From a scheduling viewpoint, there are several attractive features. First, the forward muon spectrometer is physically compatible with a 90° lepton detector of the type described by Lederman. In addition, successful operation of the 90° spectrometer will require suppression of forward hadrons produced by beam-gas interactions near the ends of the straight sections. The necessary shielding at one end is provided by these iron toroids. It is emphasized that magnetic field containment within the iron toroids effectively removes the possibility of interference with synchrotron tuning. (auth)

54182 (BNL-17092) WEAK INTERACTIONS AT ISABELLE '72. Lederman, L. M. (Brookhaven National Lab., Upton, N. Y.). 18 Jul 1972. 14p. Dep. NTIS.

A weak interaction experiment is proposed; $p + p \to \mu^+ + \nu_\mu +$ anything which will work at maximum luminosity proposed for ISABELLE. The above reaction, in which only the muon is measured, is shown to have remarkably good resolution in Q^2, the mass-squared of the outgoing lepton pair. Neutral weak currents

may interfere with electromagnetic currents in the reaction p + p → $\mu^+ + \mu^-$ + anything. (auth)

54183 (CEA-N-1553) EXPERIMENTAL STUDY OF THE $K^+ \to \pi^+\pi^-e\nu$ DECAY: DETERMINATION OF THE $\pi\pi$ PHASE SHIFT BY THE PAIS-TREIMAN METHOD. Basile, Pierre (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). May 1972. 144p. (In French). Dep. NTIS (U. S. Sales Only).

640 events observed in a $K^+ \to \pi^+\pi^-e^+\nu$ spark chamber experiment were analyzed, and the pion-pion phase difference was measured for dipion masses lower than 420 MeV. The method used was a Pais-Treiman method where the phase difference is determined without any interference of the other decay parameters. The formalism is extended to the case where the detection efficiency must be taken into account. The tests effected confirmed the possibility of using the method in the phase difference determination. The results obtained (phase difference = 25 deg ± 12 deg) are discussed and compared with theoretical predictions and other experimental data. (France)

54184 (LBL-4) NEUTRINO MASS LIMITS FROM THE $K_L^0 \to \pi^\pm l^\pm \nu$ DECAY SPECTRA. Johnson, Rolland P.; Clark, Alan R.; Elioff, T.; Frisch, H. J.; Shen, G.; Kerth, Leroy T.; Wenzel, W. A. (California Univ., Berkeley. Lawrence Berkeley Lab.). 2 Aug 1971. Contract W-7405-eng-48. 13p. (CONF-710810-6). Dep. NTIS.

From Meeting on particles and fields; Rochester, N. Y. (30 Aug 1971).

A double magnetic spectrometer at the Bevatron was used to study the low neutrino energy ends of the $K_L^0 \to \pi\mu\nu$ ($K_{\mu 3}$) and $K_L^0 \to \pi e\nu$ (K_{e3}) decay spectra. The resolution of the apparatus and absolute invariant mass calibration were determined from $K_L^0 \to \pi^+\pi^-$ events accumulated with the K_{13} events. A partial analysis yields neutrino mass upper limits (90% C.L.) of 1.0 MeV for the muon neutrino and 1.1 MeV for the electron neutrino. (auth)

54185 (NEIC-RR-47) COSMIC ν. Kuchowicz, B. (Nuclear Energy Information Center, Warsaw (Poland)). 1972. 129p. Dep. NTIS (U.S. Sales Only).

A review is presented of all the major developments in cosmic neutrino research from 1965 to the early part of 1972. Solar neutrinos, the universal Fermi interaction and stellar evolution, extrasolar sources of neutrino radiation, cosmological neutrinos, neutrinos from cosmic radiation, and theoretical developments are covered. (J.F.P.)

54186 K^+ DECAY IN FLIGHT. Chiang, I-h. (Univ. of Rochester, N. Y.); Rosen, J. L.; Shapiro, S.; (and others). Phys. Rev., D; 6: No. 5, 1254-65(1 Sep 1972). COO-881-331.

From a sample of 10^5 K^+ decays in flight the following branching ratios were obtained: $K_{\mu 2}$ = (63.24 ± 0.44)%, $K_{\pi 2}$ = (21.18 ± 0.28)%, $\tau(K^+ \to \pi^+\pi^+\pi^-)$ = (5.56 ± 0.20%, $\tau'(K^+ \to \pi^+\pi^0\pi^0)$ = (1.84 ± 0.06)%, $K_{\mu 3}$ = (3.33 ± 0.16)%, and K_{e3} = (4.86 ± 0.10)%. The phase-space distributions for three-body semileptonic modes were studied in detail from a second sample of 10^5 decays. For 4017 $K^+ \to \pi^0e^+\nu$ events, $\lambda_+ = 0.029 \pm 0.011$. Limits on scalar and tensor form factors of $|f_s/f_+| < 0.13$ and $|f_T/f_+| < 0.75$ (90% confidence) were obtained. For $K^+ \to \pi^0\mu^+\nu$ a parametrized fit to 3900 events assuming $\lambda_+ = \lambda_- = +0.030$ gave $\xi = -0.09 \pm 0.28$. (auth)

54187 MEASURING OF THE BRANCHING RATIO $\Gamma(K_L \to 3\pi^0)/\Gamma(K_L \to \pi^+\pi^-\pi^0)$. Barmin, V V.; Barylov, V. G.; Davidenko, G V.; (and others) (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz.; 15: No. 6, 1152-3(Jun 1972). (In Russian).

The branching ratio $\Gamma(K_L \to 3\pi^0)/\Gamma(K_L \to \pi^+\pi^-\pi^0) = 1.65 \pm 0.07$ was measured with the help of the ITEP 180 liter xenon bubble chamber. (auth)

54188 CP AND THE THREE PION DECAY OF THE K^0. Mallary, Michael Leigh. Pasadena, Calif.; California Inst. of Tech. (1972). 177p. University Microfilms Order No. 72-22,556.

Thesis.

The time distribution of the decays of an initially pure K^0 beam into $\pi^+\pi^-\pi^0$ was analyzed to determine the complex parameter W (also known as η^{+-0} and (x + iy)). The K^0 beam was produced in a brass target by the interactions of a 2.85 GeV/c π^- beam which was generated on an internal target in the Lawrence Radiation Laboratory (LRL) Bevatron. The counters and hodoscopes in the apparatus selected for events with a neutral (K^0) produced in the brass target, two charged secondaries passing through a magnet spectrometer and a γ-ray shower in a shower hodoscope. From the 275 K apparatus triggers, 148 $K \to \pi^+\pi^-\pi^0$ events were isolated. The presence of a γ-ray shower in the optical shower chambers and a two-prong vee in the optical spark chambers were devices used to isolate the events. The backgrounds were further reduced by reconstructing the momenta of the two charged secondaries and applying kinematic constraints. The best fit to the final sample of 148 events distributed between .3 and 7.0 K_S lifetimes gives: ReW = −.05 ±.17 and ImW = $+.39^{+.35}_{-.33}$. This result is consistent with both CPT invariance (ReW = 0) and CP invariance (W = 0). Backgrounds are estimated to be less than 10% and systematic effects have also been estimated to be negligible. An analysis of the present data on CP violation in this decay mode and other K^0 decay modes has estimated the phase of ϵ to be 45.3 ± 2.3 degrees. This result is consistent with the super weak theories of CP violation which predicts the phase of ϵ to be 43°. This estimate is in turn used to predict the phase of η^{00} to be 48.0 ± 7.9 degrees. This is a substantial improvement on presently available measurements. The largest error in this analysis comes from the present limits on W from the world average of recent experiments. The $K \to \pi\mu\nu$ mode produces the next largest error. Therefore further experimentation in these modes would be useful. (Diss. Abstr. Int., B)

54189 MEASUREMENT OF THE MUON ENERGY IN THE DECAY $\pi^+ \to \mu^+ + \nu$. Shrum, Edgar Vaughan. Charlottesville, Va.; Univ. of Virginia (1972). 84p. University Microfilms Order No. 72-22,639.

Thesis.

The muon energy following positive pion decay from rest is measured with a Ge(Li) detector using sixteen electronic sampling systems to obtain the shape of the pion decay pulse. The muon energy determined from this experiment is 4.1207 ± 0.0036 MeV. This can be used to set an upper limit on the muon neutrino mass of 1.15 MeV/c^2, at a confidence level of 90%. Assuming the neutrino mass to be exactly zero, the positive pion mass can be calculated. This gives a positive pion mass of 139.576 ± 0.025 MeV/c^2. The negative pion mass can be compared with this as a check on charge independence. $M_{\pi^-}/M_{\pi^-} = 1.00001 \pm 0.0002$ is found. Making no assumptions on the neutrino mass gives a value for the positive pion mass of $M_{\pi^-} = 139.644 \pm 0.134$ MeV/c^2, and $M_{\pi^-}/M_{\pi^+} = 0.99952 \pm .00097$. (Diss. Abstr. Int., B)

54190 STUDY OF THE PROPERTIES OF THREE-PRONG DECAYS OF K^- MESONS IN FLIGHT IN A HYDROGEN BUBBLE CHAMBER. Lucas, Peter Wayne. New Haven; Yale Univ. (1972). 243p. University Microfilms Order No. 72-22,396.

Thesis.

Properties of the decays τ, $K_{\pi 2}$, K_{e3}, $K_{\mu 3}$, and τ' were studied through observation of three prong decays of K^- mesons in flight in the BNL 30'' hydrogen bubble chamber. The decays with one charged prong have been detected through the observation of Dalitz decays of π^0's. The estimated numbers of events are combined to yield branching ratios which are consistent with those for K^+. The slopes of the Dalitz plots for the τ and τ' decay modes were measured. The τ results are consistent with a bubble chamber experiment of comparable statistics measuring the same quantity and inconsistent with a high statistics spectrometer measurement. The τ' result is consistent with measurements of this quantity for K^+ decays. (Diss. Abstr. Int., B)

Strong (Baryon-induced)

Refer also to abstracts 53766, 54467, 54503, and 54512.

54191 (BNL-17065) MEASUREMENT OF THE PROTON-PROTON TOTAL CROSS SECTION BY BEAM ATTENUATION. Marx, Jay N.; Sandweiss, Jack (Brookhaven National Lab., Upton, N. Y.). 2 Aug 1972. 8p. Dep. NTIS.

A method for the measurement of the total rate of beam interactions in colliding proton beams is proposed. This technique, which directly measures a modulated beam attenuation far from the interaction region, can be combined with an independent luminosity determination to yield the proton-proton total cross section to better than 1%. (auth)

54192 (BNL-17141) CHARGED PARTICLE MULTIPLICITY AND ANGULAR CORRELATION MEASUREMENTS IN pp AND γp COLLISIONS. Arnold, R.; Finocchiaro, G.; Grannis, P.; Kirz, J.; Quigg, C.; Carroll, A. S. (Brookhaven National Lab., Upton, N.Y.). 1972. 29p. Dep. NTIS.

A proposed experiment to measure charged particle multiplicity and angular correlations in p + p and γ + p interactions is discussed. The experimental and theoretical motivation for the study, a possible experimental setup using multiwire proportional chambers or wide-gap spark chambers, background, and requirements on the ISA are covered. (J.F.P.)

54193 (JINR-E1-6613) DIFFERENTIAL CROSS SECTIONS OF THE ELASTIC p-p SCATTERING IN THE ENERGY RANGE OF 8 TO 70 GeV. Beznogikh, G. G.; Buyak, A.; Kirillova, L. F.; (and others) (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1972. 26p. Dep. NTIS (U. S. Sales Only).

The tables of the absolute differential cross sections of the

elastic p-p scattering are presented together with the values of the slope parameter $B = (d/dt)\,[\ln(d\sigma/dt)]$, and the real part parameter $a = [ReA(0)]/[ImA(0)]$ (A(0) is the amplitude of the elastic p-p scattering at t = 0). The cross section data were obtained at Serpukhov accelerator over 8 to 70 GeV in the t – range of 0.0007 – 0.12 $(GeV/c)^2$. (auth)

54194 (JINR-E1-6615) DIFFERENTIAL CROSS SECTIONS OF THE ELASTIC p-d SCATTERING IN THE ENERGY RANGE OF 10 TO 70 GeV. Beznogikh, G. G.; Buyak, A.; Kirillova, L. F.; (and others) (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1972. 17p. Dep. NTIS (U. S. Sales Only).

The tables of the absolute differential cross sections of the elastic p-d scattering are presented. The cross section data were obtained at Serpukhov accelerator over 10 to 70 GeV in the t-range of 0.002 to 0.2 GeV^2/c^2. The elastic p-d scattering amplitude was parametrized as: $A(t) = (d\sigma/dt)^{\frac{1}{2}}_{pT}\ (1 + a) \cdot \exp\,[1/2\ (Bt + Ct^2)]$. The values $a = [ReA(0)]/[ImA(0)]$, B and C are presented in these tables also. (auth)

54195 (LA-4874, pp 36-44) OVERVIEW OF THE LAMPF RESEARCH PROGRAM. Feshbach, Herman (Massachusetts Inst. of Tech., Cambridge). Mar 1972.

From fifth LAMPF users meeting; Los Alamos, NM. (8 Nov 1971).

A review of research proposals at LAMPF is given. Types of strong interactions (hadrons), weak interactions (muons), and the weak interaction itself (neutrino physics) are outlined. (W.H.K.)

54196 VELOCITY DISTRIBUTION OF SECONDARY π MESONS FROM 22.6-GeV/c PROTON-NUCLEUS INTERACTIONS IN EMULSION. Roy, T.; Daftari, I. K. (Jadavpur Univ., Calcutta). Phys. Rev., D; 6: No. 5, 1217-19(1 Sep 1972).

Emulsion plates exposed to a 24-GeV proton beam are scanned. A velocity distribution of the secondary π mesons produced in such nuclear interactions is obtained. A Gaussian-type function is observed to simulate the experimental data and the usual phenomena of isotropy in the center-of-mass frame. The results indicate that the assumption of the constant velocity for all the secondary particles is only an approximation to the real world. (auth)

54197 INVESTIGATION OF ELASTIC pd-SCATTERING IN THE DIFFRACTION CONE REGION IN THE ENERGY RANGE 10 TO 70 GeV. Bartenev, V. D.; Beznogikh, G. G.; Buyak, A.; (and others) (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 15: No. 6, 1174-80(Jun 1972). (In Russian).

The results on measuring the slope parameter of the diffraction cone b and the ratio a of the real part of the amplitude to the imaginary one in elastic pd scattering at momentum transfer $|t| < 0.2\ (GeV/c)^2$ are presented. It was found, that b increases, a changes from -0.29 ± 0.05 up to -0.14 ± 0.05 with the proton energy increase from 10 up to 70 GeV. The experiment was carried out at the IHEP accelerator. (auth)

54198 COMPARISON OF PION MOMENTUM DISTRIBUTIONS IN 19 GeV/c pp COLLISIONS WITH AND WITHOUT STRANGE-PARTICLE PRODUCTION. Marquit, E. (Univ. of Copenhagen). Nucl. Phys.; B46: No. 2, 568-72(1972).

A comparison is made of the inclusive π^- momentum spectra for pp interactions at 19 GeV/c with V^0 and without V^0 (or any other strange-particle signal). It is found that the spectra for interactions with a V^0 and charged-particle multiplicity n are rather similar to the spectra for interactions without a V^0 and multiplicity n + 2. (auth)

54199 ANALYSIS OF $K\bar{K}$ AND $K\bar{K}\pi$ RESONANCES PRODUCED IN $\bar{p}p$ ANNIHILATIONS AT 1.2 GeV/c. Duboc, J. (Univ., Paris); Goldberg, M.; Makowski, B.; (and others). Nucl. Phys.; B46: No. 2, 429-48(1972).

The analysis of 18,900 V^0 events is presented, with reference to the production of $K\bar{K}$ and $K\bar{K}\pi$ resonances in the three-, four-, five- and six-body final states. It is established that there is a threshold structure in the $(K\bar{K})_{I=1}$ state which comes entirely from the decay of $K\bar{K}\pi$ resonances, the D^0 and E^0. The S^* and E^0 are definitely observed. The isospin of the D^0 is confirmed to be 0, $J_{D^0} \geq 1$ and, under the assumption $L_{D\omega} = 0$, $J^{PC}_D = 1^{2+}$. The F_1 is observed in the final state $F_1\eta^0$ and the analysis of this channel leads to the conclusion that $J^{PC}_{F_1} = 1^+$ or 2^-. In the five-body final state there is some appearance of two-peaks in the D^0 mass region, but with the present statistics there is no clear evidence for this effect. The cross sections for single and associated resonance production are given. (auth)

Strong (Meson-induced)

Refer also to abstracts 54232 and 54317.

54200 (BNL-17069) SOME THOUGHTS ABOUT PION-PROTON INTERACTION EXPERIMENTS AT ISABELLE. Lee, Y. Y. (Brookhaven National Lab., Upton, N. Y.). 27 Jul 1972. 6p. Dep. NTIS.

A possibility of doing pion-proton colliding beam experiments at ISABELLE is investigated. The rate is low and ~40 events/hour, however, it is found that events to background ratio is very favorable. (auth)

54201 (CERN/HERA-72-1) COMPILATION OF CROSS SECTIONS. I. π^- AND π^+ INDUCED REACTIONS. Bracci, E.; Droulez, J. P.; Flaminio, E.; Hansen, J. D.; Morrison, D. R. O. (European Organization for Nuclear Research, Geneva (Switzerland)). 11 May 1972. 183p. Dep. NTIS (U.S. Sales Only).

A compilation of cross sections for reactions produced by negative and positive pions on targets of protons, neutrons, and deuterons is presented. This is an updated version of CERN/HERA 70-5 and 70-7, and contains 40% more data than the earlier publications. Graphs of the variation of cross section with incident laboratory momentum are plotted. Values of the rate of decrease of cross section with incident momentum are given. (105 figures, 8 tables) (auth)

54202 (COO-1195-238) REACTION $K^+n \rightarrow K^+\pi^-p$ AT 3.8 GeV/c. Marshall, Don Allen (Illinois Univ., Urbana). Oct 1972. Contract AT(11-1)-1195. 192p. Dep. NTIS.

Thesis.

The ANL 30-inch bubble chamber was exposed to a separated K^+ beam at 3.8 GeV/c. The 300,000 pictures were scanned for 3- and 4-prong events. After measuring all of the 4-prong events with a stopping track and 61% of the 3-prong events, 4919 events were reconstructed which kinematically fit the reaction $K^+d \rightarrow K^+\pi^-pp$; this cross section was found to be 1.78 ± 0.10 mb. The reaction is dominated by the quasi-two-body interaction $K^+n \rightarrow K^{*0}(890)p$; this cross section was found to be 0.80 ± 0.07 mb. Results of an analysis of the spin density matrix elements indicate 0^- exchange is dominant. The reaction $K^+n \rightarrow K^{*0}(1420)p$ was examined for the effect reported by Firestone et al. The effect was confirmed, but the interpretation of the effect at 3.8 GeV/c as a broad S-wave resonance is clouded by a possible interpretation involving a secondary scattering between the spectator proton and the decay products of the K*(1420). (auth)

54203 (COO-1428-308) S-WAVE STRUCTURE IN THE $K\pi$ SYSTEM. Cords, D.; Carmony, D. D.; Garfinkel, A. F.; Loeffler, F. J.; Rangan, L. K.; (Purdue Univ., Lafayette, Ind.).; Lander, R. L.; Pellett, D. E.; Yager, P. M. (California Univ., Davis); Meiere, F. T.; Yen, W. L. (Indiana-Purdue Univ., Indianapolis). 1972. 13p. Dep. NTIS.

The $K\pi$ spectrum (4827 events) of the reaction $K^+n \rightarrow K^+\pi^-p$ at 9 GeV/c was analyzed and independent of any particular assumption of the production mechanism the existence of a broad S-wave enhancement was found. Since its phase with respect to the K*(890) P-wave is correctly given by a relativistic Breit-Wigner amplitude, this enhancement was interpreted as a resonance of mass $1.305 \pm .030\ GeV/c^2$ and width $0.330 \pm .060$ GeV. (auth)

54204 (COO-1428-310) PROPOSAL FOR AN ADDITIONAL EXPOSURE OF 9 GeV/c K^+ MESONS IN THE 80" D_2 FILLED CHAMBER. Carmony, D. Duane (Purdue Univ., Lafayette, Ind. Dept. of Physics). 1972. 11p. Dep. NTIS.

An additional 600,000 pictures of K^+ interactions in the 80" deuterium filled chamber are requested. Details of $K^*_N(1760)$ and $K^*_N(2200)$ production and decay will be studied and the various decay modes compared with the SU(3) predictions. (auth)

54205 (COO-1428-311) EVIDENCE FOR A NEUTRAL MESON NEAR 1033 MeV. Garfinkel, A. F. (Purdue Univ., Lafayette, Ind.); Hoffman, E. W. (Argonne National Lab., Ill.); Jacobel, R. W.; Cheshire, D. L.; Lamb, R. C.; Peterson, F. C. (Iowa State Univ. of Science and Technology, Ames). 1972. 12p. Dep. NTIS.

In a scintillation counter experiment studying the reaction $\pi^-p \rightarrow M^0n$ at 2.4 GeV/c, evidence was obtained for a neutral meson denoted $M^0(1033)$ with a mass of 1032.6 ± 2.3 MeV and a width of $16.2 \pm^{4}_{3}$ MeV. (auth)

54206 (COO-2009-36) INDIANA UNIVERSITY SPARK CHAMBER GROUP TECHNICAL PROGRESS REPORT, DECEMBER 1, 1971-NOVEMBER 30, 1972. Ankenbrandt, C. M.; Brabson, B. B.; Crittenden, R. R.; Heinz, R. M.; Neal, H. A. (Indiana Univ., Bloomington). [nd]. Contract AT(11-1)-2009. 10p. Dep. NTIS.

Research on the A_2 resonance and strong interactions using spark chambers is summarized. (J.F.P.)

54207 (COO-3064-3) REACTION $\pi^-p \rightarrow p\pi^+\pi^-\pi^-\pi^0$ AT 20 Gev/c. Sisterson, L. K.; Harrison, W. C.; Heyda, D.; Johnson, W. H. Jr.; Kim, J. K.; Law, M. E.; Mueller, J. E.; Salzberg,

B. M. (Harvard Univ., Cambridge, Mass. Lyman Lab. of Physics). 1972. 48p. Dep. NTIS.

Data from the reaction $\pi^-p \to p\pi^+\pi^-\pi^-\pi^0$ at 20 GeV/c are studied in detail. The cross sections for the production of ρ, η^0 and ω^0 mesons, and $\Delta(1236)$ isobars are estimated. The channels $p\eta^0\pi^-$ and $p\omega^0\pi^-$ are compared with a double Regge pole model calculation and the cross section for the contribution from individual diagrams calculated. The data are divided by the method of longitudinal phase space and each category examined in detail. A search is made for possible production of $\rho^-(1700)$, A_1^0 and A_1^+ and upper limits placed on their cross sections. (auth)

54208 (COO–3065-16) π^- INTERACTIONS IN DEUTERIUM AT 7 GeV/c. Katz, W. (Rochester Univ., N. Y. Dept. of Physics and Astronomy). 1971. Contract AT(11-1)-3065. 150p. (UR–387). Dep. NTIS.

Results are presented from a study of π^- deuterium interactions at an incident beam momentum of 7 GeV/c. The experiment to be described was performed at the 80-inch deuterium-filled bubble chamber at the Brookhaven National Laboratory AGS. The size of the exposure is such as to yield ~7 events per μb of cross section. The reactions to be discussed are the following: (1) $\pi^-d \to pp\pi^-\pi^-$, (2) $\pi^-d \to pp\pi^-\pi^-\pi^0$, (3) $\pi^-d \to pp\pi^-\pi^- + N\pi^0$, N > 1, (4) $\pi^-d \to pp\pi^+\pi^-\pi^-\pi^-$, (5) $\pi^-d \to pp\pi^+\pi^-\pi^-\pi^-\pi^0$, and (6) $\pi^-d \to pp\pi^+\pi^-\pi^-\pi^- + N\pi^0$, N > 1. Stimulated by recent symmetry arguments a search was conducted for multipion resonances having two units of electric charge. No significant evidence was found for these exotic states in reactions (1), (2), (4) and (5); the upper limit for the production of such resonances in these reactions is ~5 μb. The s-wave and d-wave $\pi\pi$ scattering phase shifts were determined using a simple extrapolation procedure for the events from reaction (1). The deduced d-wave phase shift has the same sign as the s-wave phase shift. The value for the I = 2 s-wave phase shift at the mass of the K meson is $-11.0 \pm 2.5°$. In order to examine the validity of spectator model (i.e., the hypothesis that in high energy experiments the deuteron can be treated as a source of essentially free neutrons and protons) the cross section for the $\Delta^0\rho^-$ channel in reaction (2) was compared with the $\Delta^{++}\rho^0$ cross section in the charge symmetric reaction $\pi^+p \to \Delta^{++}\rho^0$ at the same incident beam momentum. Assuming isotopic spin invariance, the ratio of these cross sections is $\frac{1}{9}$; the observed ratio is found to be consistent with this prediction. This result suggests the validity of the spectator model. (auth)

54209 (JINR–P1-6414) RECONSTRUCTION OF DIFFERENTIAL CROSS SECTION OF THE REACTION $\pi^-p \to \pi^0(\eta)n$ IN THE SMALL TRANSFERRED MOMENTA REGION. Khvastunov, M. S. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1972. 8p. (In Russian). Dep. NTIS (U.S. Sales Only).

A method is discussed for reconstruction of the emission angle of the $\pi^0(\eta)$ meson in the reaction $\pi^-p \to \pi^0(\eta)n$ over the opening angle of photons from the $\pi^0(\eta)$ meson decay and over the energy of this meson. It is shown that with this method precision measurements of the direction and the momenta of the incident π^- meson and of the opening angle of photons from the $\pi^0(\eta)$ meson decay are needed in order to guarantee an acceptable accuracy in t square of the transferred 4-momentum which is determined through the $\pi^0(\eta)$ meson emission angle. Carrying out of these conditions gives an error in t (for the method discussed) several times smaller than that for the direct method when reconstruction of the $\pi^0(\eta)$ meson flight direction is made over the emission angles of photons from the $\pi^0(\eta)$ meson decay and over the energies of these photons measured with an available accuracy. The advantages of the method discussed over the direct one are especially appreciable in the region of small t ($t \approx 0.001$ (GeV/c)^2). (2 tables) (auth)

54210 (NP-19419) MEASUREMENT AND ANALYSIS OF THE CROSS SECTION FOR THE REACTION $K^-p \to \bar{K}^0n$ AT MEDIUM ENERGY. Bricman, Claude (Paris Univ., Orsay France)). 1972. 167p. (In French). Dep. NTIS (U. S. Sales Only).

A measurement of the partial cross section for the reaction $K^-p \to \bar{K}^0n$ between 1 and 3 GeV/c is described. Although the measurement is simple from the point of view of technique, the effect of interactions of n and $\bar{K}^0$ in the final state in the counters is not easy to evaluate. The method used to take account of these interactions is discussed. Study of the variation with momentum of the cross section for $K^-p \to \bar{K}^0n$ permitted confirming the existence and defining the parameters of the most important resonances between 1.9 and 2.3 GeV: $\Sigma(1910)$, $\frac{5}{2}^+$; $\Sigma(2030)$, $\frac{7}{2}^+$; $\Lambda(2100)$, $\frac{7}{2}^-$; and $\Lambda(2350)$, $\frac{9}{2}^+$. It is shown that the principal resonances (of high spin) can be identified with recurrences of stable particles (Λ and Σ) or of well-known resonances ($\Lambda(1520)$, $\frac{3}{2}^-$ and $\Sigma(1385)$, $\frac{3}{2}^+$). The resonances can also be classified by the SU(3) scheme. All the principal resonances were placed in the singlets, octets, or decuplets; one can expect that high-spin resonances to be found at higher energies will be placed with equal facility in the multiplets. The situation is more confusing for the case of resonances not found on the principal trajectories; the majority cannot be classified, and the strange partners of a great number of resonances found during πN analyses have not yet been found. (32 figures, 11 tables, 96 references) (R.W.R.)

54211 (RPP/H–95) MEASUREMENTS OF K^+p ELASTIC DIFFERENTIAL CROSS-SECTIONS FOR KAON MOMENTA BETWEEN 0.9 AND 1.9 GeV/c. Charles, B. J.; Cowan, I. M.; Edwards, T. R. M.; (and others) (Rutherford High Energy Lab., Chilton (England)). 1972. 27p. Dep. NTIS (U. S. Sales Only).

The results of K^+p differential and total elastic cross-section measurements at seventeen values of the kaon laboratory momentum between 0.9 and 1.9 GeV/c are presented. The data come from an experiment carried out at the Rutherford High Energy Laboratory, using the 7-GeV proton synchrotron Nimrod. An enriched K^+ secondary beam was focussed at a liquid hydrogen target, and arrays of acoustic spark chambers and scintillation counters detected the incident and scattered particles. (auth) (UK)

54212 (TID–26138) HIGH ENERGY COUNTER GROUP PROGRESS REPORT, JANUARY 1, 1971–DECEMBER 31, 1971. (State Univ. of New York, Stony Brook). 1971. Contract AT-(11-1)-3472. 34p. Dep. NTIS.

The activities of the High Energy Counter Group can be divided into three parts: analysis of data on past experiments, experimentation at the CERN Intersecting Storage Rings, and preparation for future experiments. Results of the experiments discussed either are being prepared for publication or have already appeared. (R.W.R.)

54213 PION–NUCLEON TOTAL CROSS SECTIONS FROM 0.4 TO 0.90 GeV/c. Davidson, D.; Bowen, T.; Caldwell, P. K.; (and others) (Univ. of Arizona, Tucson). Phys. Rev., D; 6: No. 5, 1199-1202(1 Sep 1972).

The total cross sections of $\pi^\pm$ on protons in the momentum interval from 0.40 to 0.90 GeV/c were measured with high relative precision. In this interval the statistical error varies between 10 and 20 μb. No new structure is observed. (auth)

54214 PARAMETRIZATION OF THE NONEVASIVE EXCHANGE PROCESSES AND BACKGROUND CONTRIBUTIONS IN THE REACTION $\pi^-p \to n\pi^+\pi^-$ AT 2.77 GeV/c. Jacobs, L. D. (CEN de Saclay, Gif-sur-Yvette, France). Phys. Rev., D; 6: No. 5, 1291-1302(1 Sep 1972).

An analysis of 20,000 events from the reaction $\pi^-p \to n\pi^+\pi^-$ at 2.77 GeV/c is performed according to a parametrization given by Froggatt and Morgan. With reasonable assumptions as to the form of the s-wave $\pi\pi$ amplitude, the low-t behavior of the mean moments and differential cross section was reproduced after obtaining best values for the parameters $\Gamma_1^{I,P}$ in a maximum-likelihood fit. The method may be termed nonevasive. Some discussion is presented on the validity of evasive extrapolation. (auth)

54215 REACTIONS $K^-p \to \Lambda\pi^0$ AND $K^-p \to \bar{K}^0n$ IN THE CENTER-OF-MASS ENERGY RANGE 1700 to 2100 MeV. Van Horn, A. J.; Ely, R. P.; Louie, J. (Univ. of California, Berkeley). Phys. Rev., D; 6: No. 5, 1275-90(1 Sep 1972).

Cross sections, angular distributions, and polarizations are presented for the reactions $K^-p \to \Lambda\pi^0$ and $K^-p \to \bar{K}^0n$ for 19 incident beam momenta in the c.m. energy range 1709–2106 MeV. Legendre-polynomial expansion coefficients to seventh order are also given for the data. The experimental procedures and results from two exposures in the Lawrence Berkeley Laboratory 25-in. hydrogen bubble chamber are discussed. (auth)

54216 FURTHER ASPECTS OF THE REACTION $\pi^-p \to \pi^-\pi^+n$ AT 8 GeV/c. Takahashi, K. (Tohoku Univ., Sendai, Japan); Sato, T.; Kitagaki, T.; (and others). Phys. Rev., D; 6: No. 5, 1266-75(1 Sep 1972).

A sample of 3567 events of the reaction $\pi^-p \to \pi^-\pi^+n$ was obtained from the measurement of about 50,600 two-prong events in an exposure of the Brookhaven National Laboratory 80-in. hydrogen bubble chamber to an 8-GeV/c π^- beam. The production and decay angular distributions for the ρ^0 were studied comparing with the predictions of the absorptive one-pion-exchange and vector-dominance models. The production and decay angular distributions of the f^0 were also analyzed and compared with the prediction of the gauge-invariance model. A study of the $\pi^+\pi^-$ mass distribution suggests an enhancement at ~2100 MeV. (auth)

54217 TWO-BODY STRANGE-PARTICLE FINAL STATES IN π^-p INTERACTIONS AT 4.5 AND 6 GeV/c. Crennell, David J.; Gordon, Howard A.; Lai, Kwan-wu; Scarr, J. Michael (Brookhaven National Lab., N. Y.). Phys. Rev., D; 6: No. 5, 1220-54 (1 Sep 1972).

Results on the following π^-p reactions involving a hyperon are studied at 4.5 and 6.0 GeV/c from a high-statistics bubble-chamber experiment. (1) $\pi^-p \rightarrow (\Lambda,\Sigma^0)K^0$: Differential cross sections and hyperon polarizations are presented. Comparison with the line-reversed reactions $\bar{K}N \rightarrow (\Lambda,\Sigma^0)\pi$ indicates the failure of the predictions of $K^*(890)$ and $K^*(1420)$ exchange degeneracy. Effective trajectories for these two reactions are compared. Shrinkage is observed in $\bar{K}N \rightarrow \Lambda\pi$ and not in $\pi^-p \rightarrow \Lambda K^0$. (2) $\pi^-p \rightarrow (\Lambda,\Sigma^0)K^*(890)^0$: Differential cross sections, hyperon polarizations, and $K^*(890)^0$ density-matrix elements are determined. $\Lambda K^*(890)^0$ decay correlations are found to impose strong constraints on the scattering amplitudes. The data indicate that both natural- and unnatural-parity exchanges contribute large, but opposite, Λ polarizations. This behavior cannot be explained by a simple exchange model utilizing K and the exchange-degenerate $K^*(890)$ and $K^*(1420)$ only. Additional trajectories or absorption effects are required to obtain the observed Λ-polarization effects. Comparison of $\Lambda K^*(890)^0$ and $\Sigma^0K^*(890)^0$ indicates the greater importance of unnatural-parity exchange in the former reaction. No evidence is observed for deviations from isospin predictions in $\Lambda K^*(890)^0$ production where $K^*(890)^0 \rightarrow K^+\pi^-$ and $K^0_S\pi^0$. (3) $\pi^-p \rightarrow \Lambda K^*(1420)^0$ and $\Lambda K^*(1300)^0$: $K^*(1420)^0$ density-matrix elements satisfying positivity constraints are determined allowing for s-wave interference effects. Evidence of the existence of a narrow $K^*(1300)^0 \rightarrow K\pi\pi$ with a dominant $K^+\rho^-$ decay mode is observed in the 4.5- and 6-GeV/c data. (4) Σ (1385), Λ(1405), Λ(1520) production: Differential cross sections for the quasi-two-body reactions $\pi^-p \rightarrow Y^0K^0$, where Y^0 is Λ(1405), Λ(1520), or $\Sigma(1385)^0$, are presented and found to have a very similar flat slope in the forward direction. Data for forward K^+ scattering in the reaction $\pi^-p \rightarrow \Sigma(1385)^-K^+$ are presented and discussed. It is argued that this forward peak cannot be explained by kinematic reflection or an s-channel effect and therefore must be due to either two-particle exchange or a single exotic exchange in the t channel. (auth)

54218 PRODUCTION OF PROTON–ANTIPROTON AND CHARGED K MESON PAIRS IN 7 GeV/c π^+d INTERACTIONS. Diamond, Ronald Norman. Madison, Wis.; Univ. of Wisconsin (1972). 224p. University Microfilms Order No. 72-18,975. Thesis.

The production of proton–antiproton and K^+K^- pairs in π^+d interactions at 7 GeV/c incident π^+ beam momentum is studied. The data consist of a 650,000 picture exposure of the Argonne 30'' deuterium filled bubble chamber. Three and four prong topologies were scanned for, measured, and fitted. Candidate $p\bar{p}$ and K^+K^- pair events were rescanned and their ionizations measured on a vidicon device. A calculation based on only the measured quantities corroborated the fits for the four constant events. Cross sections are obtained for the final states $p_spK^+K^-$, $p_sp\bar{p}p\bar{p}$, $p_sNK^+K^-\pi$, and $p_sN\bar{p}p\bar{p}\pi$. The reactions studied here appear to be peripheral in nature and comparison is made between the slope of the momentum transfer distribution for the four constraint events and for the $p_sp\pi^+\pi^-$ final state. Resonance production appears to be more important for K^+K^- final states than for $p\bar{p}$. Indications of the S*(1070), f^0(1260), A_2^0(1310), K_sK_s(1440), f'(1514), g(1660), and ρ(1710) are seen in the K^+K^- mass spectrum. In the $p\bar{p}$ mass spectrum by contrast there is only a single small enhancement near 2.02 GeV/c^2. The threshold enhancement in the K^+K^- mass spectrum is well fitted by Breit–Wigner resonances, though statistics are not sufficient to rule out the complex scattering length interpretation. The $f^0 \rightarrow K^+K^-$ and $A_2^0 \rightarrow K^+K^-$ cross sections and branching ratios are obtained. In this K^+K^- mass region the angular distributions show strong S wave, as well as possible S and D wave interference effects. Possible f^0-A_2^0 interference was investigated. The D wave appears to be sizable up to a K^+K^- mass of 1.6 GeV/c^2. The $p_sN\bar{p}p\pi$ final state mass spectra are well described by phase space. In the $p_sNK^+K^-\pi$, the Δ(1238) is the most prominent resonance produced and virtually no $K^*(890)$ is seen, an observation similar to what is observed in the final state $\pi^-pK_sK_s$ for 7 GeV/c π^-p interactions. (Diss. Abstr. Int., B)

54219 PARTIAL WAVE ANALYSIS OF THE $\pi\pi$ SPECTRUM TO 1.5 GeV/c^2: A STUDY OF THE REACTION $\pi^+d \rightarrow p_sp\,\pi^+\pi^-$ AT 13 GeV/c. Barton, Henry Ruwe Jr. Lafayette, Ind.; Purdue Univ. (1972). 143p. University Microfilms Order No. 72-21,156. Thesis.

The $\pi\pi$ spectrum from the reaction $\pi^-d \rightarrow p_sp\,\pi^+\pi^-$ has been studied in an 8.8 event/μb exposure at 13 GeV/c incident π^+ momentum. The production cross sections for ρ and f mesons decaying into $\pi^+\pi^-$ were measured to be 108 ± 11 μb and 59.8 ± 6.0 μb respectively. A maximum likelihood fit to the dipion decay distributions was made to determine the density matrix as a function of dipion mass and momentum transfer. The decay angular distribution was divided into partial waves by assuming the mass dependence of the factorized dipion production amplitude. The isotropic background in the $\pi\pi$ spectrum was found to be large for all dipion masses to 1.5 GeV/c^2. From this, one may conclude that the I = 0 S-wave phase shift is approximately 90 degrees throughout this mass interval. In the range $0.005 < |t| < 0.36$ (GeV/c)^2 covered with adequate statistics by this experiment, the fraction of isotropic background in the $\pi\pi$ spectrum increased with larger momentum transfer. When these data were compared to photoproduction data at 16 GeV/c, a violation was observed for one of the predictions based on vector meson dominance. When the comparison was made using the separated P-wave of this experiment, the disagreement with vector meson dominance extended over the entire range $0.005 < |t| < 0.36$ (GeV/c)^2. The data were used to test a model which attempts to give the t dependence of the density matrix elements in terms of three constants. When the values of the three constants were determined at different values of momentum transfer, sizable fluctuations of the three parameters were found. Disagreement between the model and the experimental density matrix elements was noted. The questionable separation of S-wave and P-wave given by the model was discussed. (Diss. Abstr. Int., B)

54220 INVESTIGATION OF THE REACTIONS $\pi^-p \rightarrow n\pi^+\pi^-$ + (1,2,3,4,5)π^0 AT GeV/c. Budagov, Y. A.; Valkar, Sh.; Vinogradov, V. B ; (and others). (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 15: No. 6, 1165-73 (Jun 1972). (In Russian).

The experimental study of the process $\pi^-p \rightarrow n\pi^+\pi^-$ + ''neutral particles'' at 5 GeV/c with the help of the JINR one meter propane bubble chamber is reported. Partial cross sections for the reactions $\pi^-p \rightarrow n\pi^+\pi^-$ + (1,2,3,4,5)π^0, angular and momentum distributions of the secondary particles in the c.m.s. were obtained. The production of resonant states was investigated. These results are compared with the predictions of various theoretical models. (auth)

54221 SCALING IN $p\pi^- \rightarrow pX^-$ AND AN ESTIMATE OF THE TRIPLE-POMERANCHUKON COUPLING. Paige, Frank E.; Wang, Ling-lie (Brookhaven National Lab., Upton, N. Y.). Nucl. Phys.; B46: No. 2, 477-82(1972).

It is shown that the CERN-IHEP data on $p\pi^- \rightarrow pX^-$ at 25 and 40 GeV/c exhibit scaling in s'/s. An estimate is given of the triple-Pomeranchukon coupling and the possibility of its measurement at NAL is discussed. (auth)

54222 CENTRAL EMISSION OF PIONS AND SEARCH FOR A SYMMETRY SYSTEM. (Aachen-Berlin-Bonn-CERN-Cracow-Heidelberg-London-Vienna-Warsaw Collaboration). Nucl. Phys.; B46: No. 2, 371-80(1972).

Results are presented on the production of pions having the same direction as the incident particles, but opposite charge, in reactions of π^+p at 8 and 16 GeV/c, π^-p at 16 GeV/c and K^-p at 10 GeV/c. The $d\sigma/dp_L^*$ distributions in the region $|p_L^*| < 0.75$ GeV/c are of the form $\exp(-A|p_L^*|)$, with unequal values of A in the forward and backward directions. A study is made of this asymmetry as a function of the mass and energy of the incoming particle. (auth)

54223 PRELIMINARY STUDY OF $\pi^+\pi^-$ SCATTERING IN THE REACTION $\pi^+p \rightarrow (\pi^+\pi^-)\Delta^{++}$ AT 13 GeV/c. Gaidos, J. A.; McIlwain, R. L.; Thompson, G.; Willmann, R. B. (Purdue Univ., Lafayette, Ind.). Nucl. Phys.; B46: No. 2, 449-59(1972).

A phase shift analysis of $\pi^+\pi^-$ scattering in the mass range 0.6 to 1.4 GeV confirms the rapid rise of the I = 0 s-wave through the $K\bar{K}$ threshold. (auth)

54224 π^-p FORWARD ELASTIC SCATTERING NEAR 1 GeV/c. Abillon, J. M.; Borg, A.; Crozon, M.; (and others) (College de France, Paris). Nucl. Phys.; B46: No. 2, 630-6(1972).

The differential cross section of the reaction $\pi^-p \rightarrow \pi^-p$ was measured in the range $0.92 \leq \cos\theta_{cm} \leq 0.99$ at 15 momenta between 0.875 and 1.580 GeV/c. The results reported complete the available data; previous measurements of this reaction do not extend beyond $\cos\theta_{cm} = 0.90$. The experimental results are compared with dispersion relation predictions. A comparison of the results for B, the slope of the differential cross section, with earlier results shows many discrepancies. (auth)

54225 RESONANCE PRODUCTION IN THE REACTIONS $K^-p \rightarrow p\bar{K}^0\pi^+\pi^-\pi^-$ AND $K^-p \rightarrow p\bar{K}^0\pi^+\pi^-\pi^-\pi^0$ AT 10 GeV/c. (Aachen-Berlin-CERN-London-Vienna Collaboration). Nucl. Phys.; B46: No. 2, 356-70(1972).

An analysis is presented of resonance production in the reactions $K^-p \rightarrow p\bar{K}^0\pi^+\pi^-\pi^-$ and $K^-p \rightarrow p\bar{K}^0\pi^+\pi^-\pi^-\pi^0$ at 10 GeV/c, performed by a maximum likelihood method. In neither process is any significant nonresonant background found. The former reaction is dominated by K^{*-}(890), Δ^{2+}(1236) and ρ^0 production and the latter by K^{*-}, Δ^{2+} and ω^0. In the second reaction there is no evidence for any ρ^0 production. Two-body intermediate states appear to be negligible, but the three-body states $K^{*-}\rho^0p$ and

$K^{*-}\Delta^{2+}\pi^-$ definitely contribute. A detailed analysis has been performed of the simultaneous resonance production in $K^-p \rightarrow \Delta^{2+}K^{*-}\pi^-$ and the predictions of a Veneziano model calculation for this quasi-three-body final state are found to be in good agreement with the experimental results. (auth)

54226 LPS ANALYSIS OF THE REACTIONS $K^+p \rightarrow K^+\pi^+\pi^-p$ AND $K^+p \rightarrow K^0\pi^+\pi^0p$. De Wolf, E.; Goldschmidt-Clermont, Y.; Grard, F.; Verbeure, F. (CERN–Brussels Collaboration, Geneva). Nucl. Phys.; B46: No. 2, 333-55(1972).

Results are presented on the reactions $K^+p \rightarrow K^+\pi^-\pi^+p$ and $K^+p \rightarrow K^0\pi^0\pi^+p$ studied with the method of the longitudinal phase space. The analysis is based on data at 7 incoming K^+ momenta, ranging from 5 to 12.7 GeV/c. The energy dependence of partial cross sections in various regions of the LPS is discussed. Evidence is presented for the dominance of diffractive processes in particular regions of the phase space and for the hypothesis of factorization. (auth)

54227 PRODUCTION PROPERTIES OF A_1^+ IN π^+p INTERACTIONS AT 5.45 GeV/c. Bloodworth, I. J.; Jackson, W. C.; Prentice, J. D.; Yoon, T. S. (Univ. of Toronto). Nucl. Phys.; B46: No. 2, 402-14(1972).

The production of the peripheral 3π mass enhancement in the A_1 region is described. The differential cross section and its variation with 3π mass is studied and the spin density matrix elements are given for the t-channel and s-channel helicity frames. As observed in π^-p interactions t channel but not s channel helicity is conserved. A Deck type double Regge trajectory exchange amplitude gives good fits to the experimental distributions. Its use is supported by the equality of ρ_{00} for the A_1 and ρ_{00} for the ρ in the t-channel, as noted by Donohue. (auth)

54228 Q REGION OF THE $K^+\pi^+\pi^-$ SPECTRUM FROM K^+ MESON INTERACTIONS IN DEUTERIUM AT 9 GeV/c. Holland, Richard Frederick. Lafayette, Ind.; Purdue Univ. (1972). 135p. University Microfilms Order No. 72-22,303.

Thesis.

The results of a study of the Q region of the $K^+\pi^+\pi^-$ spectrum produced by a 9 GeV/c K^+ meson beam targeted on a deuterium filled bubble chamber are contained in this report. The data, which was obtained from a 360,000 exposure run at the Brookhaven National Laboratory, was processed and analyzed at Purdue University. An analysis of the $K^+\pi^+\pi^-$ spectrum indicates that the Q is a diffractively produced enhancement which may contain two isospin one-half resonances. The two resonances are possibly mixed states of K*'s belonging to two separate SU(3) nonets. A spin-parity analysis of the region indicates that the two resonances are consistent with $J^P = 1^+$, although $J^P = 2^-$ cannot be completely ruled out. The decay modes of the Q are primarily $K^*_{890}\pi^+$ (70 percent) and $K\rho$ (30 percent). There is very little, if any, three body decay. (Diss. Abstr. Int., B)

54229 SOME FINAL STATES WITH A Λ IN K^-n INTERACTIONS AT 4.9 GeV/c. Korpi, John Leonard Cleveland; Case Western Reserve Univ. (1972). 93p. University Microfilms Order No. 72-18,702.

Thesis.

The results of a 5.43 μb/event exposure of the deuterium-filled Brookhaven National Laboratory 80-inch bubble chamber are reported. In particular K^-n reactions with a Λ hyperon and a single charged particle in the final state are considered. Total and differential cross sections are presented for the final states $\Lambda\pi^-$, $\Sigma^0\pi^-$, $\Lambda\pi^-\pi^0$, $\Lambda\pi^-MM$, $\Lambda\pi^-\eta$ and $\Lambda\pi^- - K^0\bar{K}^0$. Resonance production cross sections and decay parameters are given for the multiparticle final states. The reaction $K^-n \rightarrow \Lambda\pi^-\pi^0$ is compared with the predictions of the generalized Veneziano model of Petersson and Törnqvist. (Diss. Abstr. Int., B)

54230 PSEUDOSCALAR-MESON-NUCLEON SCATTERING AND REGGE CUTS; AND AN EXPERIMENTAL STUDY OF THE $K_L^0 \rightarrow K_S^0$ REGENERATION AMPLITUDE IN COPPER. Roth, Timothy Stephan. Pittsburgh; Carnegie-Mellon Univ. (1972). 146p. University Microfilms Order No. 72-21,602.

Thesis.

A simultaneous fit to the data on the four charge exchange reactions ($\pi^-p \rightarrow \pi^0n$, $K^-p \rightarrow \bar{K}^0n$, $K^+n \rightarrow K^0p$ and $\pi^-p \rightarrow \eta n$) is made using a Regge pole model modified by the inclusion of the lowest order Regge cuts produced by means of the impact parameter representation. A measurement of the $K_L^0 \rightarrow K_S^0$ regeneration amplitude in copper is performed using a two arm wire spark chamber magnetic spectrometer in a neutral beam at the Argonne National Laboratory ZGS. There are several kaon nucleon resonance states in the beam momentum range 500–1500 MeV/c covered by the experiment, and their effect on the regeneration amplitude is demonstrated. (Diss. Abstr. Int., B)

54231 INELASTIC K^+p REACTIONS AT INCIDENT MOMENTA FROM 1.27 GeV/c TO 2.17 GeV/c. Loken, Stewart Christian. Pasadena, Calif.; California Inst. of Tech. (1972). 113p. University Microfilms Order No. 72-22,608.

Thesis.

A number of recent experiments have suggested the possibility of a highly inelastic resonance in K^+p scattering. To study the inelastic K^+p reactions, a 400 K exposure was taken at the L.R.L. 25-inch bubble chamber. The data are spread over seven K^+ momenta between 1.37 and 2.17 GeV c. Cross sections were measured for the reaction $K^+p \rightarrow pK^*\pi^+$ which is dominated by the quasi-two body channels $K\Delta$ and K^*N. Both these channels are strongly peripheral, as at other momenta. The decay of the Δ is in good agreement with the predictions of the rho-proton analogy of Stodolsky and Sakurai. The data on the K*p channel show evidence of both pseudo scalar and vector exchange. Cross sections for the final state $pK^+\pi^+\pi^-$ show a strong contribution from the quasi-two body channel $K^*\Delta$. This reaction is also very peripheral even at threshold. The decay angular distributions indicate the reaction is dominated as at higher momenta by a pion exchange mechanism. The data are also in good agreement with the quark model predictions of Bialas and Zalewski for the K* and Δ decay. (Diss. Abstr. Int. B)

54232 APPARATUS FOR SPIN-ROTATION MEASUREMENTS IN PION–PROTON SCATTERING AT HIGH ENERGIES. Autones, P.; Brisson, J. C.; Boucherie, A.; (and others) (CEN, Saclay, France). Nucl. Instrum. Methods; 103: No. 2, 211-23(1972).

Measurements of spin-rotation parameters allow a complete determination of the pion–nucleon scattering amplitudes when the differential cross section and the polarization normal to the scattering plane are known. This requires the scattering of pions by a proton target that is polarized along a direction in the scattering plane and analysis of the polarization of the recoil protons in a carbon plate polarimeter. Scintillation counter hodoscopes associated with fast logic allow the spark chambers of the polarimeter to be triggered mainly on elastic scatterings by the free protons in the target. (auth)

Particle Interactions and Properties (Theoretical)

Refer also to abstract 54698.

54233 (LA-DC-72-848) NEUTRINO–DEUTERON INTERACTION CROSS SECTIONS AT LAMPF ENERGIES. Brolley, John E. (Los Alamos Scientific Lab., N. Mex.); Huffman, Arthur H. (California Inst. of Tech., Pasadena). [nd]. 4p. (CONF-720819–4). Dep. NTIS.

From International conference on few particle problems in nuclear interactions; Los Angeles, CA. (28 Aug 1972).

The cross section for the process $\nu + d \rightarrow 2p + e^-$ for neutrino energies in the neighborhood of 50 MeV was calculated using proton and deuteron wave functions fitted to recent data and a recently determined value of the coupling constant. Meson exchange corrections were included. The results are compared with previous data. (J.W.R.)

General

Refer also to abstract 54385.

54234 (BNL–50342) WHAT IS AN ELEMENTARY PARTICLE? Peierls, Ronald F. (Brookhaven National Lab., Upton, N. Y.). 9 Apr 1972. Contract AT(30-1)-16. 10p. Dep. NTIS.

The search for the ultimate constituents of matter has been going on since before the time of Democritus. The investigation of the internal structure of protons and neutrons using high energy accelerators leads to some conceptual difficulties. If protons are bombarded by protons many "fragments" are produced, but these cannot be readily understood as constituents of the proton. When high energy electrons are scattered by the electrical distribution of the proton, the proton acts as if composed of independently acting point charges, but such a description does not describe other aspects of the proton's behavior. The large number of different short-lived particles which have been observed in the past two decades can all be understood as different combinations of three fundamental "quarks," but the dynamics of their interactions does not seem to make sense. An attempt is made to present the current point of view of the physicist in considering this ancient question. (auth)

54235 (COO–264–611) NEW FORM FACTORS IN THE DUAL RESONANCE MODEL. Willemsen, Jorge F. (Chicago Univ., Ill. Enrico Fermi Inst. Chicago Univ., Ill. Dept. of Physics). Jul 1972. Contract AT(11-1)-264. 15p. Dep. NTIS.

A new set of fields, satisfying a Mobius invariant equation, is

used in a dual model of vector currents. The elastic form factor exhibits power-law fall off, but the inelastic νW_2 structure function does not scale. (auth)

54236 (COO-1428-303) ANNUAL PROGRESS REPORT, TASK B, JUNE 1, 1971-MAY 31, 1972. (Purdue Univ., Lafayette, Ind. Dept. of Physics). [nd]. Contract AT(11-1)-1428. 27p. Dep. NTIS.

Theoretical research on particle interactions is summarized. A list of publications is included. (J.F.P.)

54237 (ITF-72-48-E) UNITARY RENORMALIZATION, POSITIVITY, AND SELFADJOINTNESS OF THE HAMILTONIAN FOR A LEE MODEL OF THE TYPE Y_{3+1}. Zolotaryuk, A. V. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1972. 21p. Dep. NTIS (U.S. Sales Only).

The Lee model in four space-time dimensions is renormalized by unitary transformation. A strongly convergent sequence of unitary operators is defined which transform a sequence of cutoff Hamiltonians to a sequence of operators converging strongly on a dense set of states. The semiboundedness from below in each sector and selfadjointness of the renormalized Hamiltonian are proved. (auth)

54238 (LYCEN-7211) AN ELEMENTARY PARTICLE TREATMENT OF NUCLEAR CURRENTS. Delorme, Jean (Lyon Univ. (France). Institut de Physique Nucleaire). Feb 1972. 103p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

The construction in the Rarita and Schwinger formalism of a vectorial function based under the transformation of the proper homogeneous Lorentz group is presented. The consequences of discrete P and T transformations are thus envisaged. Operations involving the SU(2) group and charge conjugation that enable the currents to be classified using the Weinberg and Cabibbo terminology, are considered. The constraints imposed by the C. V. C. and P. C. A. C. hypotheses on the form factors are defined. It is then shown how this formalism is transformed into the multipolar formalism of Galindo and Pascual. Comparisons can be made with classical methods using the impulse approximation and charge exchange corrections (when necessary). In this way, the non-relativistic contents of the various form factors are studied. After attempting to define the present day limits of elementary particle treatment methods, examples of the applications of such methods are given: treatment of small currents of the second class, muon capture reactions, and the radiative capture of pions in the $^6Li \rightarrow {}^6He$ transition. (France)

54239 SOME GENERAL PROPERTIES OF REPRESENTATIONS OF LOCAL CURRENTS. Divakaran, P. P. (Tata Inst. of Fundamental Research, Bombay). Ann. Phys. (N. Y.); 72: No. 2, 512-23(Aug 1972).

Some properties of representations of local current operators are studied. The currents are assumed to be conserved and to have charge densities transforming like the regular representation of any internal symmetry group G containing the isospin SU_2. The representation space is the "physical" Hilbert space, having a positive definite metric and carrying time-like positive-energy representations of the Poincaré group. The main results are that, in every irreducible representation space, arbitrarily large irreducible representations of G must occur, and the mass spectrum is unbounded and continuous from some point onwards if it is not strictly degenerate. These results have strong implications for current algebra saturation schemes, both at finite and infinite momentum. (auth)

54240 HIGH ENERGY PHYSICS INDEX. VOLUME 10, No. 14, 1972. Leopoldshafen, Ger.; Zentralstelle fuer Atomkern-energie-Dokumentation (1972). 82p.

54241 HIGH ENERGY PHYSICS INDEX. VOLUME 10, No. 15, 1972. Leopoldshafen, Ger.; Zentralstelle fuer Atomkern-energie-Dokumentation (1972). 88p.

54242 HIGH ENERGY PHYSICS INDEX. VOLUME 10, NO. 16, 1972. Leopoldshafen, Ger.; Zentralstelle fuer Atomkern-energie-Dokumentation (1972). 78p.

Electromagnetic

Refer also to abstracts 53776, 53893, and 54176.

54243 (DESY-72/30) k^2-DEPENDENCE OF THE TRANSVERSE PION ELECTROPRODUCTION CROSS SECTION IN A GENERALIZED BORN TERM MODEL. Gutbrod, F.; Kramer, G. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Jun 1972. 22p. Dep. NTIS (U. S. Sales Only).

Data on π^+ electroproduction off protons are analyzed in a generalized Born term model, where the off-shell nucleon form factor $F_1(k^2)$ is allowed to differ from its on-shell value. The longitudinal-transverse interference cross section is sensitive to the ratio of the nucleon form factor to the pion form factor, and the data require this ratio to be larger than one. The resulting transverse cross section, integrated over a small t interval, follows the slow decrease of the total inelastic cross section as a function of the photon mass squared. (6 figures, 4 tables) (auth)

54244 (DESY-72/36) POLARIZATION EFFECTS IN DEEP INELASTIC LEPTON-NUCLEON SCATTERING. Walsh, T. F. (Hamburg Univ. (West Germany). Institut fuer Theoretische Physik (II)); Zerwas, P. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Apr 1972. 36p. Dep. NTIS (U. S. Sales Only).

An introduction is given to questions related to polarization experiments in deep inelastic lepton-nucleon scattering. After discussing the kinematics a summary is presented of the results from different models which have been proposed as descriptions of spin effects in the Bjorken scaling region. Longitudinal and perpendicular asymmetries at various incident lepton energies and scattering angles are estimated in order to show how to distinguish between models which give nearly identical results for spin averaged cross sections. (auth)

54245 (IS-T-531) THEORETICAL TREATMENT OF THE SCHWARZ-HORA EFFECT. Hadley, George Ronald (Ames Lab., Iowa). Aug 1972. Contract W-7405-eng-82. 56p. Dep. NTIS.

Thesis.

In the Schwarz-Hora effect, an electron beam passing through a crystal is modulated by laser light and then reproduces the light when it strikes a nonluminescent target. The theory for the modulation process is developed for incident plane wave electrons using the Born approximation to second order. A wave packet treatment of the incident electrons is also included to study interparticle phasing. Finally, light production at a nonresonant target is discussed classically and quantum mechanically, and an upper limit for the amount of light emitted at the laser frequency is calculated using a semiclassical model. (auth)

54246 (JINR-P2-6636) AUTOMODEL ASYMPTOTIC OF THE SPECTRAL FUNCTIONS OF VIRTUAL COMPTON EFFECT. Matveev, V. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1972. 37p. (In Russian). Dep. NTIS (U. S. Sales Only).

Strict mathematical grounds are given for the consistency of the hypothesis about automodel asymptotic behavior of the spectral functions of the virtual Compton effect in the range of high energy and large momenta of a photon. The relation between the automodel asymptotic and the behavior of the electromagnetic current commutator in the vicinity of the light cone is studied. (auth)

54247 (NP-19417) PION ELECTROPRODUCTION AT THRESHOLD. Note No. 268. Benfatto, G.; Nicolo, F.; Rossi, G. C. (Rome Univ. (Italy). Istituto di Fisica). 29 Mar 1972. 32p. Dep. NTIS (U. S. Sales Only).

A method to calculate the axial nucleon form factor, g_A, and the electromagnetic pion from factor, F_π, at threshold is discussed. The theoretical ingredients are gange invariance, low energy theorems and t-fixed dispersion relations. Also the errors involved in the unavoidable approximations are discussed. (auth)

54248 (ORO-3992-106) S MATRIX ELEMENTS IN THE PRESENCE OF STANDING WAVE STATES, THE BJORKEN LIMIT, AND SHADOW-QUARKS. Nelson, C. A. (Louisiana State Univ., Baton Rouge. Dept. of Physics and Astronomy. Texas Univ., Austin. Center for Particle Theory). Aug 1972. Contract AT(40-1)-3992. 51p. (CPT-160). Dep. NTIS.

When a scattering reaction occurs, it is usually assumed that the complete set of collision states is entirely composed of traveling waves, hence any constituent, in principle, is observable. Should, however, either quarks regulator photons or lepton satellites be standing wave states, i.e. only shadow states, one would not expect to have observed them. The new terms which modify the usual dispersion relations and Low equation are discussed, and it is argued that present two-body experiments do not provide strong tests for their presence. In the Bjorken limit these piecewise analytic terms vanish. Yet, in a shadow indefinite-metric theory, the logarithmic terms breaking this limit are still absent. The triangle anomalies, therefore, should only be taken seriously in low-energy reactions. A stronger constraint on the presence of shadow states can be provided by verification of the Callen-Gross sum rule. By means of a simple version of the Kuti-Weisskopf model, containing valence quarks and quark-antiquark pairs, it is

demonstrated explicitly how quarks can be shadow states. In formal scattering theory with shadow states, the correct formal solutions for the exact asymptotic states, both physical and shadow, are obtained. (auth)

54249 INVESTIGATION OF LINEAR POLARIZATION OF SYNCHROTRON RADIATION. Nikitin, M. M. (Tomsk Polytechnic Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 12, 133-5(1970). (In Russian).

The linear polarization of synchrotron radiation from 300- to 1200-MeV electrons was studied for the vertical angular distribution of intensities. The calculated results are given. (J.F.P.)

54250 BREMSSTRAHLUNG OF SOFT PHOTONS IN REACTION $p + p \rightarrow \pi^+ + d + \gamma$. Shekhter, L. Sh. (Saratov State Univ., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 12, 29-32(1970). (In Russian).

An amplitude was found for soft-photon bremsstrahlung in the process $p + p \rightarrow \pi^+ + d + \gamma$. This amplitude is expressed in terms of $p + p \rightarrow \pi^+ + d$ scattering amplitudes. (J.F.P.)

54251 CHIRAL SYMMETRY AND STRUCTURE OF THE NUCLEON. Chapline, George F. Jr. Phys. Rev., D; 6: No. 5, 1324-8(1 Sep 1972).

Starting from the nonlinear σ model it is shown that for large momentum transfer the proton charge form factor is approximately equal to $(1 + Q^2/Q_0^2)^{-2}$, where the constant Q_0 is related by a simple transcendental equation to the pion-nucleon coupling constant f and to a constant f_π related to the charged-pion decay rate. Using the experimental values of f and f_π Q_0 = 800 MeV is obtained. The charge radius of the proton is calculated to be 0.85 F. Further, it is shown that the "hard core" radius for nucleon-nucleon interactions should be approximately equal to $(2/Q_0)$ = 0.5 F. An interpretation of the most prominent pion-nucleon resonances is also offered. (auth)

54252 LOW-ENERGY THEOREM FOR $\gamma\gamma \rightarrow 3\pi$ AND THE REACTION $\gamma + Z \rightarrow 3\pi + Z$. Smith, J.; Stanko, N. (State Univ. of New York, Stony Brook). Phys. Rev., D; 6: No. 5, 1332-9 (1 Sep 1972).

Recently a low-energy theorem was proposed by Adler, Lee, Treiman, and Zee and by Terent'ev for the reaction $2\gamma \rightarrow 3\pi$. This theorem is supposed to be valid at an unphysical point in the production amplitude. One possible way to test its reliability is to measure the reaction $e^+e^- \rightarrow e^+e^- + 3\pi$ which unfortunately has a very small cross section. In this paper another reaction is investigated which may allow a more satisfactory check of the low-energy theorem, namely, the photoproduction of three pions off a target nucleus. Cross sections, angular and energy distributions, and invariant-mass plots are given for several beam energies assuming a lead target. The η-meson background is also examined. (auth)

54253 TEST OF THE ALGEBRA OF BILOCAL OPERATORS. Iliopoulos, J. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France); Paschos, E. A. Phys. Rev., D; 6: No. 5, 1340-6(1 Sep 1972).

It is shown that the electroproduction of massive muon pairs provides a test of the algebra of bilocal operators. The cross section for the contribution of the Compton term is derived and estimates of the background terms are indicated. As expected, numerical estimates indicate that the cross sections are fairly small. (auth)

54254 EVALUATION OF THE J = 0 FIXED POLE IN NEUTRON COMPTON SCATTERING. Dominguez, C. A.; Gunion, J. F.; Suaya, R. (Stanford Univ., Calif.). Phys. Rev., D; 6: No. 5, 1404-11(1 Sep 1972).

The recent deuteron Compton data are used to evaluate the J = 0 fixed pole in neutron Compton scattering. This calculation includes the effects of both Glauber and Fermi-motion corrections in the extraction of the free-neutron cross section from the deuteron data. The result is consistent with the Born answer, zero. As a by-product, it is shown that the $f: A_2$ ratio in Compton scattering is much larger than previously expected. (auth)

54255 COMPTON SCATTERING. I. SPECTRAL FORMS FOR THE INVARIANT AMPLITUDES TO ORDER e^4. Milton, Kimball A.; Tsai, Wu-yang; DeRaad, Lester L. Jr. (Univ. of California, Los Angeles). Phys. Rev., D; 6: No. 5, 1411-27 (1 Sep 1972).

The six invariant amplitudes for Compton scattering are explicitly calculated to order e^4. Gauge-invariant amplitudes which are free of kinematic singularities and zeros are derived in double-spectral form. They are calculated in the framework of Schwinger's source theory which makes crucial use of causality and space-time extrapolation. The accompanying single-spectral forms (contact terms) are determined by analysis of forward scattering. The resulting amplitudes contain all the information necessary to calculate radiative corrections to polarized electron-photon scattering experiments. (auth)

54256 COMPTON SCATTERING. II. DIFFERENTIAL CROSS SECTIONS AND LEFT-RIGHT ASYMMETRY. Tsai, Wu-yang; DeRaad, Lester L. Jr.; Milton, Kimball A. (Univ. of California, Los Angeles). Phys. Rev., D; 6: No. 5, 1428-38(1 Sep 1972).

The differential cross sections for polarized electron-photon scattering are calculated to order e^6 and the unpolarized result of Brown and Feynman is rederived. The left-right asymmetry is calculated for a polarized target electron in agreement with Miller and Wilcox. This leaves the disagreement between theory and experiment unresolved. These results are obtained by using the six invariant amplitudes in spectral form, which were calculated in the preceding communication. (auth)

54257 DEEP-INELASTIC CONTRIBUTION TO BARYON ELECTROMAGNETIC MASS DIFFERENCES. Katsumori, Hiroshi (Chubu Inst. of Tech., Nagoya, Japan). Phys. Rev., D; 6: No. 5, 1438-44(1 Sep 1972).

Unsubtracted dispersion relations for $t_1(q^2,\nu)$ and $t_2(q^2,\nu)$ are proposed even in the case of the $\Delta I = 1$ mass difference, with the requirement of the absence of divergences worse than logarithmic ones. By the use of the experimental data on the inelastic nucleon structure functions, the possibility is shown that the deep-inelastic effect leads to the correct sign of the observed n-p mass difference. In consideration of the experimental fact that the ratio of structure functions, $W_{2,n}/W_{2,p}$, in the range where the greater part of the contribution to the relevant integral results is not far away from the threshold value as $\omega/2M \rightarrow 1$ predicted by Bloom and Gilman, the deep-inelastic part of the n-p mass difference is effectively written in the form of the magnetic-moment-type self-energy. It is also shown that if this is similarly applicable to other baryons, and if the SU(3) magnetic-moment relations hold, the correct signs and right orders of magnitude of the mass differences $\Sigma^- - \Sigma^+$, $\Xi^- - \Xi^0$, as well as $\frac{1}{2}(\Xi^+ + \Sigma^-) - \Sigma^0$, are reproduced by the theory with no adjustable parameter except an input of the observed n-p mass difference. (auth)

54258 COMMENT ON THE POSSIBLE RELATION BETWEEN PROMINENT RESONANCES AND LIMITING SCALING DATA IN INELASTIC ELECTROPRODUCTION ON NUCLEONS. Pestieau, Jean (Instituto Politecnico Nacional, Mexico City). Phys. Rev., D; 6: No. 5, 1449-50(1 Sep 1972).

A recent parametrization of a relation between prominent resonances and limiting scaling data in inelastic electroproduction on nucleons is shown to be incompatible with experiment, unless the electromagnetic current has an isotensor component. (auth)

54259 $\eta \rightarrow 3\pi$ DECAYS IN A MODEL SATISFYING ANALYTICITY, CROSSING SYMMETRY, AND APPROXIMATE UNITARITY. Picciotto, Charles; Smith, Donald (Univ. of Victoria, B.C.). Phys. Rev., D; 6: No. 5, 1450-2(1 Sep 1972).

Recently developed solutions to Moffat's model for meson-meson scattering are applied to the decays $\eta \rightarrow 3\pi$ and $K \rightarrow 3\pi$. Very good fits to the data are obtained. (auth)

54260 ROLE OF NEUTRAL VECTOR MESONS IN THE PHOTOFORMATION OF LEPTON PAIRS BY NUCLEI. Kerimov, B. K.; Ablakulov, Kh. A.; Sadykhov, F. S. (Moscow State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz.; 36: No. 1, 194-7(Jan 1972). (In Russian).

An expression for the differential cross section of photoproduction of $e^+ - e^-$ pairs at a point nucleus with spin $\frac{1}{2}$ was obtained from a model of vector dominance. The expression corresponded to two Compton diagrams. The participation of neutral vector mesons (ρ^0, ω, and φ) leads to the appearance of a peak in the angular dependence of the cross section of the process. (tr-auth)

54261 DISPERSION RELATIONS AND DATA FOR THE REACTION $\gamma n \rightleftharpoons p\pi^-$ IN THE 33-RESONANCE REGION. Aznauryan, I. G.; Zaslavskii, A. N. (Inst. of Physics, Erevan). Yadern. Fiz.; 15: No. 6, 1261-5(Jun 1972). (In Russian).

It is shown that there is a difference between prediction of dispersion relations and experiment for the isovector part of photoproduction amplitude. This difference cannot be canceled by introduction of isotensor electromagnetic current. For the analyzed isotopic combination the result practically does not depend upon possible uncertainties in the solution of dispersion relations. (auth)

54262 e^+e^--PAIR ANNIHILATION AND DEEP INELASTIC ep-SCATTERING IN PERTURBATION THEORY. Gribov, V. N.; Lipatov, L. N. (Inst. of Nuclear Physics, Leningrad). Yadern. Fiz.; 15: No. 6, 1218-37(Jun 1972). (In Russian).

The connection between e^+e^- annihilation into hadrons and deep inelastic ep scattering in pseudoscalar theory and vector

theory with conserving current was considered. It is shown, that in the both theories there is simple relation between structural functions $W(\omega, \xi)$ and $W^a(\omega, \xi)$, that describe ep scattering and e^+e^- annihilation, if antiproton is selected in the final state. This relation is: $W^a(\omega, \xi) = -(1/\omega) \cdot W(1/\omega, \xi)$, where ω – the Bjorken variable, ξ – some function of q^2, that is expressed in logarithmic approximation $g^2 \ln q^2 \sim 1$, $g^2 \ll 1$ as an integral by the invariant charge. Similar relation for $\widetilde{W}(\omega, \xi)$ and $\widetilde{W}^a(\omega, \xi)$ describing electron-meson scattering and annihilation with a selected meson in final state, appears to be valid only for large $q^2(\xi \gg 1)$. As for analytic connection of $W(\omega,\xi)$ and $W^a(\omega, \xi)$ (assumed by Drell et al.) is absent in vector theory. The functions $W^a(\omega, \xi)$ and $\widetilde{W}^a(\omega, \xi)$ obtained in logarithmic approximation, satisfy simple sum rules. (auth)

54263 PRODUCTION OF MUONIC PAIRS IN μp-COLLISIONS. Kobrinskii, M. N.; Tikhonin, F. F. (Inst. of High Energy Physics, Moscow). Yadern. Fiz.; 15: No. 6, 1238-42(Jun 1972). (In Russian).

The process of electroproduction of lepton pairs is considered. The matrix element squared was calculated. The masses of all the particles and the target recoil was taken into account. The numeric results deal with the muonic trident process on proton. At the initial energy 30 GeV an angular distribution of the final muons, the mass spectrum of a muonic pair with different charges, and the total cross-section of the process were obtained. The problem of the contribution to the cross section of different types of the diagrams was considered, and in this it was revealed that the process is fully determined by the "space-like" diagrams (a–d) only. (auth)

54264 RADIATION FROM A CHARGE IN THE FIELD OF TWO PLANE WAVES. Khalilov, V. R. (Moscow State Univ.). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 3, 76-9(1972). (In Russian).

The problem of radiation from a relativistic charge in a field of two plane electromagnetic waves was examined, where the propagation of both waves was in the same direction. The total intensity and the spectral-angular distribution of the polarized radiation were found. Several special cases were also investigated. (tr-auth)

54265 STRUCTURE OF OBSERVABLE AMPLITUDES FOR PHOTON-SOFT-PION INTERACTION. Terent'ev, M. V. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz.; 15: No. 6, 1199-1217(Jun 1972). (In Russian).

The processes $\gamma\gamma \to \pi\pi$, $\gamma\pi \to \pi\pi$, $\gamma\gamma \to 3\pi$ with "soft" pions are considered. It has been exhibited, that the amplitude of the process $\gamma\gamma \to \pi\pi$ is defined with pole diagrams, if γ-quanta are real; and if they are extremely virtual it is expressed via spectral-functions of the vector and axial currents. $\gamma\pi \to \pi\pi$ amplitude is expressed via "f" constant of π^0-meson decay. This relation is the main result; it is fulfilled in case the anomalous condition for divergences of neutral axial current is valid. The amplitude of the process $\gamma\gamma \to 3\pi$ is expressed through $\gamma\pi \to \pi\pi$ and $\pi^0 \to 2\gamma$ amplitudes. Possible experimental tests of the relations obtained are discussed. (auth)

54266 PAIR PRODUCTION IN ELECTROMAGNETIC FIELD (CASE OF ARBITRARY SPIN). Marinov, M. S.; Popov, V. S. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz.; 15: No. 6, 1271-85(Jun 1972). (In Russian).

Quasiclassical method of "imaginary time" is generalized for the case of a spin particle. The production probability of pairs in strong electromagnetic field for particles with an arbitrary spin and magnetic moment is calculated. (auth)

54267 p–p BREMSSTRAHLUNG CALCULATIONS AND RELATIVISTIC SPIN CORRECTIONS. Liou, M. K.; Sobel, M. I. (Brooklyn Coll.). Ann. Phys. (N. Y.); 72: No. 2, 323-52 (Aug 1972).

The Hamiltonian for p–p bremsstrahlung, including relativistic corrections to the Pauli–Schrodinger equation, is discussed in detail. The cross section for this process is derived, and calculations, based on the Hamada–Johnston potential with and without relativistic corrections, are presented. When the relativistic spin correction is neglected the results, here found by calculating the amplitude in the c.m. frame, are quite different from results found previously by using the lab frame; however, when the relativistic correction is included, then the lab and c.m. calculations are in agreement with each other, and also with experimental data. The correction is small in the c.m. frame and large at higher energies in the lab frame. Comparisons between theory and experiment are made at various energies, and for cases of unequal proton polar angles, and noncoplanar scattering. (16 figures) (auth)

54268 π^0 ELECTROPRODUCTION AT THE FIRST RESONANCE AT MOMENTUM TRANSFERS $q^2 = 0.6$, 1.0, AND 1.56 GeV^2. Alder, J. C. (DESY, Hamburg); Brasse, F. W.; Chazelas, E.; (and others). Nucl. Phys.; B46: No. 2, 573-92(1972).

Recent measurements on the electroproduction of π^0 mesons in the region of the first pion nucleon resonance at four momentum transfers of $q^2 = 0.6$ and $q^2 = 1$ GeV^2 are extended to $q^2 = 1.56$ GeV^2. All the results are discussed in terms of angular coefficients and multipole amplitudes. Assuming that the angular distributions are dominated by the magnetic dipole M_{1+}, the square of the magnetic dipole amplitude and its interference terms with the multipoles E_{0+}, S_{0+}, E_{1+}, S_{1+} and M_{1-} are determined. The results are compared with theoretical models. The dependence of $|M_{1+}|^2$ on the invariant mass W at different q^2 is discussed by comparison with a standard Breit Wigner formula. (auth)

54269 TWO-PHOTON EXCHANGE EFFECTS IN DEEP INELASTIC ELECTROPRODUCTION. Kingsley, R. L. (Univ. of Cambridge, Eng.). Nucl. Phys.; B46: No. 2, 615-29(1972).

The order of magnitude of expected contributions to deep inelastic electron-proton scattering which are of higher order in the fine structure constant than those usually considered is examined in a spin $\frac{1}{2}$ parton model. They are found to be probably negligible in their contribution to the inelastic electron-proton scattering cross section. (auth)

54270 PROPERTIES OF THE PION EXCHANGE CONTRIBUTION TO TWO AND QUASI TWO BODY REACTIONS. Gotsman, E.; Maor, U. (Tel-Aviv Univ., Israel). Nucl. Phys.; B46: No. 2, 525-37(1972).

The structure of the t-channel unnatural parity exchange contribution to two and quasi two body reactions is examined. A method in which the absorbed pion exchange contribution is strongly suppressed for $-t \geq 0.2$ GeV^2 is discussed. A hybrid model is presented which enables us to concurrently provide a consistent description of reactions in which the pion exchange plays an important role. This is achieved without recourse to additional parameters. (auth)

54271 CONTRIBUTION TO THE SIXTH-ORDER ELECTRON AND MUON ANOMALIES. Billi, D. (Univ., Bologna); Caffo, M.; Remiddi, E. Lett. Nuovo Cim.; 4: No. 14, 657-60(5 Aug 1972).

The sixth-order contribution to the electron and muon anomalous gyromagnetic ratios a_e, a_u, was evaluated analytically from simple Feynman graphs. (L.B.S.)

54272 PION–MUON MODEL AND LINEAR MASS RELATIONS. Tangherlini, F. R. (Coll. of the Holy Cross, Worcester, Mass.). Lett. Nuovo Cim.; 4: No. 14, 671-7(5 Aug 1972).

Some further development of the pion–muon model presented recently is given as well as some mass regularities that were suggested by this model. The results are summarized by the following rule: There exist very precise, linear, rational mass relations, even for particles that belong to different multiplets, inclusive of leptons. These relations are found to hold with accuracies ranging from 230 to 20 ppm. (L.B.S.)

54273 INFORMATION ON THE PION FORM FACTORS FROM THE ABSENCE OF ZEROS. Raszillier, I. (Inst. of Physics, Bucharest). Lett. Nuovo Cim.; 4: No. 14, 690-2(5 Aug 1972).

Information on the pion electromagnetic form factor was previously derived from analyticity, normalization, and bounds given on its modulus by $e^+e^- \to \pi^+\pi^-$ data. The additional information brought by the hypothesis is that the pion form factor has no zeros inside its analyticity domains. (L.B.S.)

54274 PHOTON STABILITY. Hare, M. G. (Univ. of Saskatchewan, Regina). Lett. Nuovo Cim.; 4: No. 14, 693-4(5 Aug 1972).

The possibility of a photon with a rest mass decaying into a neutrino-antineutrino pair is examined. An expression is derived for the lifetime that varies as the inverse square of the photon rest mass, thus showing that a massless photon would be completely stable. It also shows that the higher the photon energy the longer the lifetime, hence the odds of detecting the decay of a photon in the electric-wave region of frequency of 1 Hz are insignificant. (L.B.S.)

54275 GENERAL APPROACH TO SCALING IN ELECTRO-INCLUSIVE REACTIONS. Bardakci, K.; Pak, N. K. (Univ. of California, Berkeley). Lett. Nuovo Cim.; 4: No. 14, 719-24 (5 Aug 1972).

A simple unified approach to off-mass shell photon processes, based on the well-known Regge picture of strong interactions, is reviewed. The analysis is extended to the electro-inclusive process. The various kinematic limits suggested by the Regge analysis are studied. The asymptotic form of the average pion multiplicity is then determined. It is found that the multiplicity goes like log ν both in the Regge (Q^2 = fixed, $\nu \to \infty$) and in the scaling (ω = fixed, $\nu \to \infty$) limits. (L.B.S.)

54276 APPLICATION OF MOFFAT'S MODEL TO $\eta \rightarrow 3\pi$ AND $K \rightarrow 3\pi$ DECAYS. Smith, Donald; Picciotto, Charles. (Univ. of Victoria, B. C.). Can. J. Phys.; 50: No. 12, 1346-9 (15 Jun 1972).

Moffat's model for meson–meson scattering, satisfying the Mandelstam representation, crossing symmetry, and Regge behavior, is applied to $\eta \rightarrow 3\pi$ and $K \rightarrow 3\pi$ decays. It is found that agreement with the data is excellent when the model is used with Lovelace's trajectory, but not as good with Moffat's trajectory. The model is also applied to the process $\pi n \rightarrow 3\pi$, and fair agreement is found in the low energy region; however, since the model is unitary only at low energies, no strong conclusions can be reached in this case. (auth)

54277 WEAK AND ELECTROMAGNETIC PROCESSES. Mikaelian, Karnig O. Stony Brook, N. Y.; State Univ. of New York (1972). 90p. University Microfilms Order No. 72-22,862. Thesis.

In Part I the production of single W bosons in electron-positron colliding beams, via the reaction $e^+ + e^- \rightarrow W^- + e^+ \nu_e$, is considered. The total cross section and angular and energy distributions of the positron and the W boson produced in the above reaction are computed. The calculation of the total cross section includes all four lowest order Feynman diagrams contributing to this process. The analysis is limited to center of mass energies $E < 2M_W$ (M_W = boson mass). In this range it is found that the contribution of two of the diagrams is negligible, but the presence of a pole in one of these diagrams invalidates all previous calculations of the total cross section for $E > 2M_W$. Total cross sections are given for three values of the boson's anomalous magnetic moment. A rather flat energy distribution of outgoing positrons and a slight peak in the high energy region of the boson energy distribution are found. The angular distribution of positrons has a very sharp forward peak (defined as the direction of the initial positrons), while the bosons are distributed mostly in the backward direction. A short discussion of the process $e^+ + e^- \rightarrow W^- + \mu^+ + \nu_\mu$ is also included. Part II is devoted to the study of radiative corrections to the general process $A \rightarrow Be^+e^-$ where A is a hadron and B is either a hadron or a photon. The radiative corrections to the $\pi^0 \rightarrow \gamma e^+e^-$ decay are first calculated over the whole range of the Dalitz plot, with no restrictions on the radiative photon energy. The corrections are found to be negative and large in magnitude in the region of large invariant mass of the Dalitz pair, and small but positive for small values of the same quantity. The total correction to the decay rate, defined by $\Gamma^{rad}(\pi^0 \rightarrow \gamma e^+e^-)/\Gamma(\pi^0 \rightarrow \gamma\gamma)$ is positive and agrees with the results of previous calculations. Consideration is then given to the general process $A \rightarrow Be^+e^-$ and an analytic formula is derived for the radiative corrections to the invariant mass spectrum of the Dalitz pair. Considering the decay of a neutral pseudoscalar particle, all the integrations indicated in this formula are performed. Finally, the results are applied to the decay $\eta \rightarrow \gamma e^+e^-$. (Diss. Abstr. Int., B)

54278 THEORY OF COMPTON SCATTERING BY A CHARGED DIRAC PARTICLE WHICH POSSESSES INTRINSIC DIPOLE MOMENTS. Kukanov, A. B.; Kuang, Tkhai (Moscow State Univ.). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 1, 113-15(1972). (In Russian).

An electric dipole moment may exist for an elementary particle only if the law regarding parity conservation is violated. For the purposes of the development a Dirac particle, an electric charge, an intrinsic magnetic dipole moment, and, in addition, an electric dipole moment are assumed. The effective differential cross section of Compton scattering was calculated for a particle initially at rest. (K.S.W.)

54279 COMPTON SCATTERING BY K-SHELL ELECTRONS. I. NONRELATIVISTIC THEORY WITH RETARDATION. Gavrila, Mihai (Univ. of Colorado, Boulder). Phys. Rev., A; 6: No. 4, 1348-59(Oct 1972).

An exact analytic calculation is presented for the cross section of the nonrelativistic Compton-type inelastic scattering of photons by electrons bound in the ground state of a hydrogen-like atom. The matrix element of the process was taken to be of the Kramers–Heisenberg–Waller form. It was integrated by the Coulomb–Green's-function method, developed previously by the author in connection with Rayleigh scattering. This is based on replacing the sum over intermediate states by the Green's function which is expressed in terms of the integral representation in momentum space given by Schwinger. The final continuum-state wave function was also described by an integral representation. Thus the evaluation of the matrix element requires the carrying out of momentum-space integrations, followed by two contour integrations. Its final form was expressed in terms of hypergeometric functions of four variables of Lauricella's type F_D. At small photon energies, where the dipole approximation is valid, the result simplifies considerably. The low-energy end of the scattered-photon spectrum is considered in detail in connection with the infrared divergence problem. The shape of the spectrum is discussed and a comparison with previous results is given. (auth)

54280 COMPTON SCATTERING BY K-SHELL ELECTRONS. II. NONRELATIVISTIC DIPOLE APPROXIMATION. Gavrila, Mihai (Univ. of Colorado, Boulder). Phys. Rev., A; 6: No. 4, 1360-7(Oct 1972).

The dipole approximation of the nonrelativistic cross section for Compton scattering by electrons bound in the ground state of a hydrogenlike atom, obtained by the present author, is computed and discussed. In this approximation the cross-section differential with respect to the angles and energy of the scattered photon is proportional to $C_1 + C_2 \cos^2\theta$, where θ is the scattering angle of the photon. The coefficients C_1, C_2 are combinations of Appell functions F_1, depending on the atomic number Z and the energies of the initial and final photons κ_1, κ_2 by means of the dimensionless variables $k_i = \kappa_i/Z^2R$, $i = 1, 2$, where R is the rydberg. In order to compute the Appell functions, these were first continued analytically and expressed in terms of other hypergeometric functions of two variables, which under our circumstances admit convergent series expansions. These were then summed numerically. The incident photon energies considered lie in the interval $1.05 \leq k_1 \leq 20$. For each value k_1 the coefficients C_1 and C_2 were computed for a number of values of k_2 ($0 \leq k_2 \leq k_1 - 1$). Special attention was given to the end points $k_2 = 0$ and $k_2 = k_1$. C_1 and C_2 turn out to be monotonically decreasing functions of k_2 presenting the infrared-divergent behavior $1/k_2$ for $k_2 \rightarrow 0$. The limitations of the result due to retardation corrections are considered. (auth)

54281 ANGULAR DISTRIBUTIONS IN THE ANNIHILATION OF AN ELECTRON–POSITRON PAIR. Kheifets, S. A.; Khoze, V. A. (Inst. of Physics, Erevan. Inst. of Nuclear Physics, Novosibirsk, USSR). Dokl. Akad. Nauk SSSR; 203: No. 2, 320-2 (11 Mar 1972). (In Russian).

Some general properties of angular distributions during two-particle annihilation of an electron-positron pair were considered. It was expedient to examine the case of polarized particles, since during prolonged motion in a magnetic field the electrons and positrons may be polarized as a result of radiation. The approach used is quite well known, but it is stressed that the basic properties of angular distributions have a completely simple origin and may be obtained without detailed computation in each separate case. (K.S.W.)

54282 QUARK MASS AND STRUCTURE FUNCTIONS FOR ELECTRON SCATTERING. Okumura, Yoshitaka (Kyoto Univ.). Progr. Theor. Phys. (Kyoto); 48: No. 1, 331-2(Jul 1972).

Deep inelastic electron scattering off a hadron is considered in the quark-parton model. The bare quark mass is estimated using the Cottingham formula and it is conjectured that mF_2 is universal for all hadrons except for the unitary spin factor. (L.B.S.)

54283 PHOTO-NEUTRAL VECTOR MESON COUPLINGS IN THE RELATIVISTIC EXTENDED QUARK MODEL. Kobayashi, Tsunehiro (Tokyo Univ. of Education). Progr. Theor. Phys. (Kyoto); 48: No. 1, 335-7(Jul 1972).

The infinite numbers of coupling constants of photo-vector meson transitions are determined in the quark model with relativistically extended internal structure. It is also shown that the photo-vector meson couplings for high mass mesons are quite large and that the existence of high mass vector mesons can be tested by the storage-ring experiments. (L.B.S.)

Weak

Refer also to abstracts 54181, 54185, 54365, and 54366.

54284 (BNL–16978) WEAK INTERACTIONS AT ISABELLE. Berman, S. M. (Brookhaven National Lab., Upton, N. Y.). 27 Jun 1972. 16p. Dep. NTIS.

The Fermi theory of weak interactions is tested in a study of the reaction $p + p \rightarrow e^+(e^-) + \nu +$ anything. The cross sections are estimated in the parton model using a point Fermi interaction between leptons and partons. Intermediate boson effects on the distributions and cross sections are included. It is found that the studied process leads to quite measurable counting rates if the luminosity is of the order of 10^{23} cm^{-2} sec^{-1} and hence could be one of the most significant investigations carried out at ISABELLE. (J.F.P.)

54285 (DESY–72/32) QUARK MODEL PREDICTIONS FOR WEAK PRODUCTION OF PSEUDOSCALAR MESONS. Koepp, G., Rein, D.; Zerwas, P. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Jun 1972. 13p. Dep. NTIS (U. S. Sales Only).

By applying the quark model to weak production of pseudoscalar

mesons, the absence of some reactions is predicted by requiring only nonexotic t-channel exchanges. Further, relationships between several production cross sections based on the additivity assumption of the quark model are derived. (1 figure, 2 tables) (auth)

54286 (DNPL/P–130) OCTET DOMINANCE IN NON-LEPTONIC DECAYS. Riazuddin (Daresbury Nuclear Physics Lab. (England)). Jul 1972. 19p. Dep. NTIS (U. S. Sales Only).

The question of Octet enhancement for the non-leptonic decays is studied within the framework of a current-algebra approach. By writing an unsubtracted dispersion relation for the matrix elements $\langle B_k|H_w|B_j\rangle$ and $\langle M_k|H_w|M_j\rangle$ (B denoting a $\frac{1}{2}^+$ baryon and M a 0^- meson) in the momentum transfer-squared variable t and using the assumption of threshold dominance, namely that two pseudoscalar meson states dominate the absorptive parts of the above matrix elements and that in the chiral limit the meson–baryon and meson–meson scattering amplitudes which enter in the absorptive parts are exactly given by current algebra low-energy theorems, it is shown that the above matrix elements are octet enhanced without assuming the octet transformation property for H_w. Further it is shown that the d′/f′ ratio for the octet-enhanced matrix elements $\langle B_k|H_w|B_j\rangle$ satisfies the relation $(d'/f') = (3/10)\,[3(f/d)_A^2 - 1/(f/d)_A]$, where $(f/d)_A$ denotes the f/d ratio of the axial vector current baryon couplings. The implications of this result for the s- and p-wave hyperon non-leptonic decays are discussed. (auth)

54287 (LBL–766) PART I: APPLICATIONS OF THE SCHWARZ INEQUALITY TO WEAK AND ELECTROMAGNETIC PROCESSES. PART II: S-CHANNEL HELICITY CONSERVATION IN ELASTIC PROCESSES. Langacker, Paul (California Univ., Berkeley. Lawrence Berkeley Lab.). 16 Mar 1972. Contract W-7405-eng-48. 76p. Dep. NTIS.

Thesis.

A class of inequalities is derived for certain weighted integrals of the spectral functions of the vector currents. The inequalities involve the low-energy p-wave meson-meson cross sections and slopes of the form factors that describe the matrix element of a vector current between single-particle pseudoscalar meson states. One set of applications involves the pion electromagnetic form factor. A lower bound on the hadronic contribution to the muon magnetic moment is estimated in terms of the pion electromagnetic charge radius r_π. The bound is twice as large as the ρ-dominance value if $r_\pi = 0.86$ F, as indicated by old data, but no useful result is obtained if one uses the value of r_π obtained in a new experiment. The inequalities can also be used to test various predictions concerning the asymptotic behavior of the e^+e^- annihilation cross section. A slowly decreasing behavior is favored over a rapidly decreasing one like $\sigma^{e^+e^-}(t) = ct^{-3}$, but more accurate data are needed to draw a definite conclusion. Another class of inequalities relates the slope parameter λ_+ of K_{l3} decays to the spectral function of the isovector electromagnetic current. Weinberg's first spectral function sum rule is used. It is shown that a large value for λ_+ (e.g., $\lambda_+ = 0.045$) is not compatible with ρ saturation of the isovector spectral function. Since the principal tests of the sum rule have relied on the additional assumption that such resonance saturations are possible, some doubt is cast on the validity, or at least on the previous applications, of the sum rule. Implications for the Weinberg mass relations, c-number Schwinger terms, and the e^+e^- annihilation cross section are discussed. The unitarity equation for elastic partial wave amplitudes is considered. Defining helicity total flip elastic amplitudes as those in which both helicities change sign, it is observed that the unitarity equation strongly suggests that the imaginary part of the helicity total flip partial wave amplitude is much smaller than that of the nonflip amplitude at high energies. Appealing to a plausibility argument, the ratio of helicity total flip to nonflip partial wave amplitudes is estimated to be $(1/s)^{\frac{1}{4}}$ or smaller. The implications of this result for the full amplitude, the possibility of extending the result to other amplitudes if factorization is true, and the implications for Regge theory are discussed. (auth)

54288 (RPP/T–26) MUON–PROTON SCATTERING AND THE EFFECT OF NEUTRAL CURRENTS IN THE SCALING REGION. Love, A.; Nanopoulos, D. V.; Ross, G. G. (Rutherford High Energy Lab., Chilton (England)). 1972. 17p. Dep. NTIS (U. S. Sales Only).

The problem of testing weak interaction models with the next generation of accelerators is discussed, and it is concluded that muon–proton scattering must be considered. The cross sections for both polarized and unpolarized targets are obtained in the scaling region. The feasibility of detecting neutral weak currents is examined and optimum kinematical conditions to do this are found. Finally, ways to isolate the neutral weak current are suggested. (auth)

54289 WEAK κ-DOMINANCE MODEL AND BOUNDS ON K_{l3} DECAY PARAMETERS. Shih, I-fu; Okubo, S. (Univ. of Rochester, N. Y.). Phys. Rev., D; 6: No. 5, 1393-1403(1 Sep 1972).

The previously found bounds on the K_{l3} form factors were improved without assuming the validity of unsubtracted dispersion relations for two-point functions and without assuming specific SW(3)-symmetry-breaking Hamiltonians. For this generality, it is necessary to assume a weak form of κ dominance for the two-point function (but not for the three-point functions). Under this assumption the two-point function may still have a nonzero and sizable contribution from the high-energy region. The derived bounds still give results inconsistent with the present experiments if the soft-pion theorem is used as input information. (auth)

54290 POSSIBLE INFLUENCE OF POLARIZED PROPERTIES OF LEPTONS ON THE FORM OF PHOTON AND ELECTRON SPECTRA WHICH ARISE FROM INELASTIC NEUTRINO–MUON SCATTERING. Romanov, Yu. I. Izv. Akad. Nauk SSSR, Ser. Fiz.; 36: No. 1, 208-11(Jan 1972). (In Russian).

The process of inelastic neutrino-muon scattering accompanied by bremsstrahlung is discussed within the framework of the four-component theory of the neutrino. The form of the photon and electron spectra was determined not only by the electromagnetic nature of the reaction, but was dependent on the components of a weak interaction. The participation of only left-polarized electrons and μ-mesons in the reaction was predicted. (tr-auth)

54291 SEARCH FOR A NEUTRAL VECTOR MESON IN K_L-DECAYS. Barmin, V. V.; Davidenko, G. V.; Demidov, V. S.; (and others). (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz.; 15: No. 6, 1149-51(Jun 1972). (In Russian).

An attempt was made to check experimentally the Alles and Pati hypothesis on existence of a neutral vector meson in K_L decays. The upper limits for the decay probabilities were found to be $\Gamma[K_L \to \chi^0 + \gamma(\chi^0 \to \pi^0 + \gamma)]/\Gamma(K_L) < 1.85 \cdot 10^{-4}$ and $\Gamma(K_L \to e^+ + e^- + \gamma)/\Gamma(K_L) < 2.7 \cdot 10^{-5}$, at 90% confidence level. It has been exhibited, that the decay $K_L \to \chi^0 + \gamma$ is at least 50 times smaller, than it is predicted by theory. (auth)

54292 WEAK RADIATIVE DECAYS OF HYPERONS IN THE POLE MODEL. Yakimiw, E. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France); Jakimiw, G. Can. J. Phys.; 50: No. 12, 1300-6(15 Jun 1972).

It is found that the pole model which includes the decuplet pole contributions in the weak radiative decays of hyperons fails to give the correct sign of the $\Sigma^+ \to p\gamma$ asymmetry parameters α, although the magnitude of the decay rate and of α is consistent with the present experimental data. This conclusion holds in the Rarita–Schwinger formalism. Earlier calculations are incorrect due mainly to an error in the spin-$\frac{3}{2}$ propagator used in the theory, and inconsistencies in the SU(3) phase convention. (auth)

54293 NONMESIC DECAYS OF HYPERNUCLEI ^{4}H AND ^{4}He IN A MODEL OF THE DIRECT TRANSITION OF THE Λ-HYPERON INTO A NEUTRON. Potashev, A. G.; Nikiforov, B. P.; Filimonov, V. A. (Tomsk Polytechnical Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 1, 86-94(1972). (In Russian).

The decay probabilities of hypernuclei $^4H_\Lambda$ and $^4He_\Lambda$ were calculated for all possible nonmeson channels: $^4H_\Lambda \to$ tn,d2n,p3n and $^4He_\Lambda \to$ ^{3}Hen,tp, dd, dpn, 2p2n. Mutual interaction in the final state between decay products was neglected, but Pauli's principle was completely allowed for in the same ultimate particles. The predominant decay channels are three- and four-particle in nature. The results were compared with experimental data. (tr-auth).

54294 THEORY OF LEPTONS. Katayama, Yasuhisa; Kobayashi, Nobuo (Kyoto Univ.). Progr. Theor. Phys. (Kyoto); 48: No. 1, 247-60(Jul 1972).

A unified theory describing four leptons, i.e., muon, electron and two neutrinos together is presented. Leptons are represented by a single fundamental field: Without any interaction the field satisfies a fourth-order differential wave equation. When the influence of the electromagnetic field is taken into account, the appearance of reactive terms in the equation makes it possible to decompose the fundamental field into two Dirac fields (electron's and muon's) and a residual field. Though the residual field interacts with the electromagnetic field in a way similar to the separated two Dirac fields, the corresponding phenomena are shown to be ineffective owing to the mechanism analogous to Bleuler and Gupta's in quantum electrodynamics, provided the right (or left) handed component of the residual field is assumed not to exist: The proposed nonlocal weak interaction of the fundamental field leads to the coupling, on the mass shell, of the charge exchange current-current type. The current of approximate V–A with small T-mixture type gives the neutrino a small mass, which causes the separation of one neutrino field from the other. From these investigations, the following problems are suggested: (i) The existence of two kinds

of neutral lepton fields with nearly zero mass would be understood in connection with their appearance through the two-component parts in nature. (ii) There would be a possible description of one pair of lepton (for instance, muon and massive neutrino) by means of the indefinite metric in Hilbert space, which is suggested by the existence of two kinds of lepton number conservation. (iii) In connection with the occurrence of lepton weak interaction, at least one of the masses of neutrinos, should be finite (non-zero), but less than the electron mass. (auth)

54295 $K_s \rightarrow 2\gamma$ DECAY. Kohara, Yoji (Tokyo Univ.). Progr. Theor. Phys. (Kyoto; 48: No. 1, 261-6(Jul 1972).

The $K_s \rightarrow 2\gamma$ decay rate is evaluated on the basis of dispersion relations and unitarity in the approximation of retaining the two-pion intermediate states. The numerical result of the branching ratio $\Gamma(K_s \rightarrow 2\gamma)/\Gamma(K_s \rightarrow \pi^+\pi^-)$ is given by 3.1×10^{-6}. (auth)

54296 POSSIBLE TESTS OF LEPTON NUMBER ASSIGNMENTS. Yokoo, Yoshimatsu (Osaka Univ.). Progr. Theor. Phys. (Kyoto); 48: No. 1, 353-5(Jul 1972).

The following scheme for assignment of lepton number is considered: a single lepton number is introduced, the signs of which are opposite for e^- and μ^-. It is proposed that a test of this scheme is provided by observing the strangeness-changing decay processes (1) $\Sigma^- \rightarrow p + \mu^- + e^-$, (2) $\Xi^- \rightarrow \Sigma^+ + \mu^- + e^-$, and (3) $K^\pm \rightarrow \pi^\pm + \mu^\pm + e^\pm$. It is pointed out that these elementary processes could give unambiguous information about the current $\mu^\pm \rightleftharpoons e^\pm$. (L.B.S.)

54297 NOTE ON THE URBARYON MODELS. Hayashi, Takemi; Karino, Tutomu; Kurokawa, Hidekazu (Hiroshima Univ.). Progr. Theor. Phys. (Kyoto); 48: No. 1, 359-60(Jul 1972).

An experimental clue is given for discriminating between the new Nagoya model and the Hiroshima model for the structure of urbaryons. Considering the interactions (1) $\nu_e + N \rightarrow \nu_e + N'$ and (2) $\nu_\mu + N \rightarrow \nu_\mu + N'$, it is pointed out that the cross sections for the reactions (1) and (2) are equal in the new Nagoya model, but in the Hiroshima model the cross section for the reaction (1) is much larger than that for the reaction (2) unless an extraordinarily larger constant than the usual one is used. This is suggested as a crucial test for choosing the urbaryon model. (L.B.S.)

Strong (General)

Refer also to abstracts 54388 and 54724.

54298 (BNL-16997) PHYSICS WITH ISABELLE. Quigg, C. (Brookhaven National Lab., Upton, N. Y.). [nd]. 18p. Dep. NTIS.

Some of the ways in which more information about the constitution and interactions of hadrons may be elucidated by means of strong- and electromagnetic-interaction experiments at ISABELLE energies are considered. Reactions leading to many-particle final states in both p + p and e + p collisions are discussed, with some emphasis on experiments well-suited to storage rings. Results on single-particle inclusive cross sections from the ISR are presented, and some speculations on deep e + p interactions in the Bjorken limit are discussed. (7 figures) (R.W.R.)

54299 (ITF-72-49-P) APPLICATIONS OF THE STATISTICAL MECHANICS METHODS IN A DUAL MODEL. Demchenko, G. P.; Kukhtin, V. V.; Struminskii, B. V. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1972. 8p. (In Russian). Dep. NTIS (U. S. Sales Only).

The distribution function for resonance spins and the dependence on mass of the elastic widths of resonances are obtained by statistical mechanics methods by using the factorization of three dual amplitudes with a finite number of oscillators. (auth)

54300 (ITF-72-53-E) STATISTICAL VIEW ON RESONANCE WIDTHS AND MULTIPLICITY IN DUAL MODELS. Gorenstein, M. I.; Makarov, V. I.; Miranskii, V. A.; Shelest, V. P.; Zinov'ev, G. M. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1972. 8p. Dep. NTIS (U. S. Sales Only).

A statistical approach to dual resonance models (DRM) is developed. Total and partial resonance widths, as well as the multiplicity of π-meson production, are calculated within the framework of such an approach. (auth)

54301 (ITF-72-55-P) TWO-PARTICLE DISTRIBUTIONS IN DUAL RESONANCE MODEL. Demchenko, G. P.; Kukhtin, V. V.; Struminskii, B. V. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1972. 24p. (In Russian). Dep. NTIS (U. S. Sales Only).

Two-particle inclusive reactions are considered on the basis of the dual resonance model. A formula for the inclusive reaction cross section is obtained. Limiting expressions for the cross section in the case of simple, double and triple Regge limits are treated; the way the correlation function is obtained is discussed. All the calculations are carried out in the physical region. The results derived support the Feynman–Yang hypothesis for the existence of the secondary-particle limiting distributions. (7 figures) (auth)

54302 (LBL-1007) PHENOMENOLOGY OF INCLUSIVE REACTIONS. Cahn, Robert N. (California Univ., Berkeley. Lawrence Berkeley Lab.). 18 Jul 1972. Contract W-7405-eng-48. 162p. Dep. NTIS.

Thesis.

Inclusive reactions are examined in the context of the Mueller formalism, which exploits the connection of the inclusive cross section with the six-point amplitude and Regge behavior. Some previous results of the model are reviewed. Internal symmetries together with the Mueller picture are used to produce a large number of testable predictions. The fundamental symmetries of the strong interactions yield predictions which test the validity of the basic assumptions of the model. SU(3) gives predictions which are expected to be violated, and thus furnish extensive information about symmetry breaking. Angular distributions yield information about behavior in the central rapidity region, if the transverse momentum distribution is known. The dual resonance model provides predictions for fragmentation and pionization, but the results are based on a naive model and do not agree with the data. Inclusive photon distributions are examined in detail. They provide information mainly about the inclusive π^0 distribution. In the low-transverse momentum region, bremsstrahlung is significant and can provide a measure of the charged multiplicity. The photon distribution arising from π^0 decays in the central region obeys an equality relating the spectrum at zero transverse momentum to the integral of the spectrum over all transverse momenta. A variety of experimental data are reviewed and compared with the preceding predictions and prescriptions. (auth)

54303 (RPP/T-25) DIFFRACTIVE MODELS IN NON-DIFFRACTIVE REGIONS. Lam, C. S. (Rutherford High Energy Lab., Chilton (England)). 1972. 9p. Dep. NTIS (U. S. Sales Only).

Within the spirit of fragmentation models, various quantities may be calculated only when behaviours in the non-diffractive regions are known. These include the dispersion of multiplicity distributions, the rate of approach to asymptotic limits, etc. A priori very little can be said about the non-diffractive region in fragmentation models. However, if it is made a condition that the invariant pion spectrum in pp inclusive collisions is to be flat in the central region, then information about the non-diffractive regions may be obtained. In particular, in the diffractive excitation model, this requires the n^{-3} law to be valid almost right up to the kinematical boundary, in a way which is specified. (auth)

54304 EXOTIC FRAGMENTING STATES IN INCLUSIVE REACTIONS. Capps, Richard H. (Purdue Univ., Lafayette, Ind.). Phys. Rev., D; 6: No. 5, 1314-17(1 Sep 1972).

The general inclusive process $a + b \rightarrow c + X$ is considered in the b fragmentation region. It is proved that if the fragmenting state ($b\bar{c}$) is exotic, the presence or absence of energy-dependent terms in the invariant cross section f cannot depend on whether or not ($ab\bar{c}$) is exotic. If f is a smooth function of the kinematic variables, there must be a nonzero but limited region of the variables, in which the energy-dependent terms for exotic ($b\bar{c}$) are small compared to their average size when ($b\bar{c}$) is not exotic. In this region, present experimental evidence is in agreement with the hypothesis that the energy-dependent terms are small when ($ab\bar{c}$) is exotic. (auth)

54305 COMMENT ON A LIMITING TEMPERATURE IN HADRON PHYSICS. Tuan, S. F. (Univ. of Hawaii, Honolulu). Contract AT(04-3)-511. Phys. Rev., D; 6: No. 5,1445-9(1 Sep 1972).

It has been pointed out by Yang that if hadron physics were indeed governed by a limiting temperature $T_0 \sim 160$ MeV, then such a far-reaching conclusion would constitute no less than the establishment of a fourth law of thermodynamics. Here brief but critical comments are made on the basis for the limiting-temperature concept with particular emphasis on its implications for the production of massive exotic hadron states. (auth)

54306 QUASI-EIKONAL APPROXIMATION. Ter-Martirosyan, K. A. (Inst. of Theoretical and Experimental Physics, Moscow). JETP Lett. (USSR) (Eng. Transl.); 15: No. 12, 519-23(20 Jun 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 15: No. 12, 734-8(20 Jun 1972).

A simple approximation for the scattering amplitude is proposed. This approximation is quite exact at high energies. Account is

taken of the contributions of the Regge poles and all rescatterings. A good description of all the known experimental data of various strong interactions was found. (J.F.P.)

54307 DUAL-AMPLITUDE ANALYSIS OF TWO-PARTICLE PRODUCTIONS. II. Jen, Chian-li; Kang, Kyungsik; Shen, Pu; Tan, Chung-I (Brown Univ., Providence). Ann. Phys. (N. Y.); 72: No. 2, 548-83(Aug 1972). (COO-3130-TA-256).

The two-particle distribution function for the process $a + b \rightarrow x_1 + x_2 +$ anything at high energy is analyzed by using the dual-resonance model. The distribution functions for all the kinematic regions are explicitly shown to have the expected variable dependence. In the uncorrelated-pionization and the double-fragmentation (this includes the ditriple Regge limit) regions, the distribution functions are factorized into the product of the corresponding single-particle distributions. To obtain the factorization requires nontrivial treatment of the singularities and the kinematic relations. The correlation effects in the pionization region are studied in detail. The transition from the correlated pionization to the uncorrelated pionization regions reveals that the correlation length in the relative rapidity y is of the order 1. For fixed y, the two-particle distribution exhibits the gross exponential cut-off behavior $f^{12} \sim \exp[-4(p_1^{\perp 2} + p_2^{\perp 2} + 2p_1^{\perp}p_2^{\perp}\cos\beta)]$, where β depends on y and the relative azimuthal angle between the two transverse momenta. (5 figures) (auth)

54308 MARKOFFIAN MODEL FOR HADRONS. Majernik, V. (Inst. of Physics, Bratislava). Nucl. Phys.; B46: No. 2, 483-96 (1972).

The hadron is considered as a system consisting of other bound hadrons, the configuration state of which changes with the time. Its time development is described as a Markov process by Kolmogorov's equations. The stationary solution of Kolmogorov's equations for the Markoffian hadronic system makes it possible to calculate certain physical parameters for stable hadrons. The calculation of the magnetic moments of the proton and neutron in this model yields values which are in good agreement with the experimental data. (auth)

54309 DUAL MODELS WITH SL(2,C) SYMMETRY. Brink, L.; Kihlberg, A. (CERN, Geneva). Nucl. Phys.; B46: No. 2, 505-24 (1972).

Making use of homogeneous space techniques, a class of dual models is constructed, which is a generalization of the Virasoro–Shapiro type of model. The integrand in the integral representation for the N-point function depends not only on the modulus of the distances between two-dimensional Koba–Nielsen variables, but also on the corresponding phases. This is in fact the most general SL(2,C) invariant amplitude that can be constructed using complex integration variables. The extra phase factors in the integrand provide a possible means of avoiding tachyons both as external particles and as intermediate states in the amplitude. When factorized in a simple-minded fashion the intercepts are fixed to be integers. Although the external particles can be chosen not to be tachyons, such states appear as intermediate states. Within this factorization it can be shown that there are gauge conditions for the amplitude that can provide a ghostkilling mechanism. (auth)

54310 GENERALIZED NONLINEAR LEE MODEL AND INFINITY SUPPRESSION DUE TO NONLINEARITY. Calogero, F. (Univ., Rome. Istituto Nazionale di Fisica Nucleare, Rome); Degasperis, A. Lett. Nuovo Cim.; 4: No. 14, 661-70(5 Aug 1972).

The generalized nonlinear Lee model is examined, starting from the finite and well-defined version of the theory when the high-energy cut-off is present, and then analyzing the effect on the physical quantities as the cut-off tends to infinity. Consideration is limited to the simpler nontrivial sector of the Hilbert space of the model (V–ΘN sector). Both the cases with non-relativistic and with relativistic kinematics (for the Θ-boson) are considered. It is shown that in the former case, the ordinary Lee model requires (infinite) mass renormalization but no (infinite) charge renormalization, the nonlinear structure of the generalized model can compensate the divergence, so as to yield finally, in the limit of point-like interaction, finite results for all quantities of physical interest. (L.B.S.)

54311 PARTON MODEL: ELASTIC AND INELASTIC FORM FACTORS OF HADRONS. Senju, Hirofumi; Kakuto, Akira (Nagoya Univ., Japan). Progr. Theor. Phys. (Kyoto): 48: No. 1, 272-80(Jul 1972).

On the basis of the idea that hadrons consist of more fundamental particles whose transverse momenta are sharply cut off at $k_\perp$ in the hadron, three physical regions are classified. In particular a new condition is added to the Drell-Levy-Yan conditions for the validity of the parton model. Based on the above analysis, explicit forms of the electromagnetic form factors of all mesons and baryons are given and moreover it is shown that $\nu W_{2n} = \nu W_{2p}$ in the region where the parton model holds, at least in regard to the data available at present. (auth)

54312 INCLUSIVE REACTION IN THE MULTIPERIPHERAL MODEL. II. TWO-PARTICLE CORRELATIONS IN THE PIONIZATION REGION. Sakai, Sunao (Tokyo Univ. of Education). Progr. Theor. Phys. (Kyoto); 48: No. 1, 329-30(Jul 1972).

The two-particle distribution function for the inclusive reaction $a + b \rightarrow c_1 + c_2 +$ anything is calculated in the multiperipheral model and a few characteristic features of the model are extracted. (L.B.S.)

54313 CUT-OFF PROBLEM IN THE INTEGRAL SPECTRUM OF ULTRAHIGH ENERGY COSMIC RAYS AND URBARYONS. Terasaki-Okada, Kunihiko (Hiroshima Univ.). Progr. Theor. Phys. (Kyoto); 48: No. 1, 349-50(Jul 1972).

The cut-off problem in the integral spectrum of ultrahigh energy cosmic rays is discussed under the assumption that cosmic urbaryons with ultrahigh energies will lose their energies dominantly by hadronic interactions with the thermal radiation which bring emission of hadrons. A rough estimate is made for the cross section for photo-pion production on urbaryons under assumed values for the mass and strength of the hadronic interaction of urbaryons. The result suggests that a steepening or a cut-off in the spectra of primary cosmic rays will occur at energies of order 10^{21} eV. (L.B.S.)

54314 MODEL OF MULTIPLE PRODUCTION BASED ON THE INTUITIVE PICTURE OF HADRONS. Sasaki, Tateaki (Tokyo Univ.). Progr. Theor. Phys. (Kyoto); 48: No. 1, 98-209(Jul 1972).

A new model of multiple production developed from the optical model is proposed and is examined in the energy region about 50 ~ 1200 GeV. Numerical calculations are made by treating it as a potential problem and by making use of Glauber's high energy approximation. The result is not unreasonable. In particular the longitudinal momentum distribution does not show the scaling behavior above ~1000 GeV. (auth)

Strong (Baryon No. = 0)

Refer also to abstract 54219.

54315 (JINR-E2-6525) ANALYSIS OF THE Kπ-INTERACTION IN THE ENERGY REGION UP TO 1 GeV. Isaev, P. S.; Khleskov, V. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab of Theoretical Physics). 1972. 22p. Dep. NTIS (U. S. Sales Only).

An analysis of the Kπ interaction in the energy region up to 1 GeV was performed by using dispersion relations for S and P waves. A set of $\delta_0^{\frac{1}{2}}$, $\delta_0^{\frac{3}{2}}$, and $\delta_1^{\frac{1}{2}}$ phase shifts satisfying simultaneously the dispersion relations is found. Resonance behavior is predicted for the $\delta_0^{\frac{1}{2}}$ phase shift in the energy region $M(K\pi) \approx$ 1.1 GeV. (auth)

54316 (RPP/T-24) UNCORRELATED JET MODEL PREDICTIONS FOR THE MULTIPLICITY DISTRIBUTION OF π^- MESONS PRODUCED IN HIGH ENERGY ANNIHILATIONS $p\bar{p} \rightarrow$ PIONS. de Groot, E. H.; Zalewski, K. (Rutherford High Energy Lab., Chilton (England)). 1972. 13p. Dep. NTIS (U. S. Sales Only).

The uncorrelated jet model is used to obtain a grand partition function for the pions produced in the process $p\bar{p} \rightarrow$ pions. The grand partition function is evaluated asymptotically for large energies. It is used to relate the correlation parameter $f_2 = \langle n_-^2\rangle - \langle n_-\rangle^2 - \langle n_-\rangle$ to the average multiplicity of negative pions $\langle n_-\rangle$. The results are consistent with the presently available experimental data, though data at higher energies are necessary to draw physically interesting conclusions. (auth)

54317 (RPP/T-27) QUESTIONS IN ππ SCATTERING AND RELATED PROCESSES. Morgan, D. (Rutherford High Energy Lab., Chilton (England)). 1972. 106p. Dep. NTIS (U. S. Sales Only).

Current activity in the field of ππ scattering and related processes is described. The material includes survey of scattering, experiment and theory, questions; extracting information from dipion production data; inferences from analyticity, crossing and unitarity; inelastic channels and related processes. It is not a comprehensive review of ππ scattering. Several important contributions appeared after the material was originally prepared and allusions to them were inserted. Reference is made to the existence, in the literature, of a number of reviews from different aspects. (auth)

54318 THREE-MESON RESONANCES IN A RELATIVISTIC FADDEEV-TYPE APPROACH. Mennessier, G. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France); Pasquier, J.-Y.; Pasquier, R. Phys. Rev., D; 6: No. 5, 1351-72(1 Sep 1972).

Three-body resonances are studied within the framework of a relativistic version of the Faddeev equations, in which the input two-body amplitudes are assumed to be separable. A first discussion concerns the simplest $\pi\pi\pi$ and $K\bar{K}\pi$ systems in which only the ρ(765 MeV) or the K*(890 MeV) resonance is taken into account. Compared to preceding works on a similar subject, more flexible parametrizations are used, allowing a larger class of two-body interactions to be considered and a better understanding of the influence of the main parameters involved in the model. A more satisfactory agreement with experiment is also found in the three-pion case and this for more realistic two-body amplitudes. The success is less convincing for the $K\bar{K}\pi$ case, but this might be due to the neglect of the two-body $K\bar{K}$ interaction. Finally the study of the $K\pi\pi$ case gives an insight into the constructive and destructive interference effects which can be observed when more than one two-body resonance is taken into account. In the Appendix some comments are made about the properties one can reasonably require for the input separable two-body amplitudes owing to potential theory or its relativistic generalizations. (auth)

54319 $I = 0$ $\pi\pi$ s WAVE AND BROKEN SCALE INVARIANCE. Pennington, M. R. (Univ. of California, Berkeley). Phys. Rev., D; 6: No. 5, 1458-60(1 Sep 1972).

Renner and Staunton have shown that an $I = 0$ $\pi\pi$ s wave with only an ϵ resonance cannot satisfy the low-energy theorems of broken scale invariance. Recent experimental results indicate that this partial-wave amplitude also has a strongly inelastic S*(980) resonance. It is shown that if contributions from this resonance are included in the calculation of Renner and Staunton the low-energy theorems can be satisfied and suggest that the dimension of the operator which breaks both scale and chiral invariance is one. Although this result is not completely conclusive, because of the approximations used, this calculation does illustrate once again that the breaking of scale invariance cannot be ascribed to the ϵ resonance alone. (auth)

54320 ANNIHILATION OF $\bar{N}N \to 3\pi$ IN DUAL MODELS. Bugrii, A. I.; Enkovskii, L. L.; Kobylinskii, N. A. (Inst. of Theoretical Physics, Kiev). Yadern. Fiz.; 15: No. 6, 1266-70 (Jun 1972). (In Russian).

The reaction $\bar{p}n \to \pi^+\pi^-\pi^-$ is studied for momentum of the incident antiproton 1,2 GeV in the framework of the Veneziano model with satellites and a dual amplitude with Mandelstam analyticity. The theoretical predictions are compared with experimental data. (auth)

54321 DYNAMIC CHIRAL SYMMETRY AND CANCELLATION OF DIVERGENCES IN MASS DIFFERENCES OF THE MEMBERS OF A_1-, ρ-, π-MESONIC ISOMULTIPLETS. Kaganovich, A. B. (Chita State Pedagogical Inst., USSR). Yadern. Fiz.; 15: No. 6, 1251-60(Jun 1972). (In Russian).

With the method of "hard pions" it was exhibited, that in cancellation logarithmic divergences in the sum of electromagnetic and weak interaction contributions to the mass differences of the members of ρ-, A_1- and π-mesonic isomultiplets the following requirements are necessary: (1) the second Weinberg sum rule in one-particle approximation; (2) equality to zero of an anomalous magnetic moment of A_1 meson; (3) the relation, that gives the mass value of intermediate boson $M_w \approx 55$ GeV. (auth)

54322 LADDER APPROXIMATION FOR THE VERTEX FUNCTION OF NONRENORMALIZABLE $\omega\rho\pi$-INTERACTION. Epifanov, Yu. N.; Filippov, A. T. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 15: No. 6, 1286-93(Jun 1972). (In Russian).

A previously proposed method to solve ladder equation for a vertex function in nonrenormalizable theories of VPP-interactions is applied to PVV-interactions, at the same time it is generalized for the case, when 4-momenta of all the particles differ from zero. Using as an example $\omega\rho\pi$-interaction, which is very important for applications, it is shown how one may obtain the expansion of the vertex function into a power series in g and ln g (modified perturbation theory). There are calculated terms $\sim g^2$ and $\sim g^2 \ln g^2$ which are compared with the estimation, obtained by cutting off a triangular diagram at the "unitary limit." Possible application of the result obtained is discussed. (auth)

54323 $\omega-\varphi$ MIXING AND PHOTON INTERACTIONS FROM AN EXTENSION OF ODORICO'S BOOTSTRAP. Capps, Richard H. (Purdue Univ., Lafayette, Ind.). Phys. Rev. Lett.; 29: No. 12, 820-3(18 Sep 1972).

The bootstrap condition applied by Odorico to the scattering of pseudoscalar mesons is extended to processes involving vector mesons and photons. The $\omega-\varphi$ mixing angle is predicted to be the quark-model value. A photon interacting as a U-spin scalar is one of a small number of solutions. (auth)

Strong (Baryon No. = 1)

Refer also to abstract 54221.

54324 (COO-1428-309) PION-NUCLEON CHARGE EXCHANGE SCATTERING IN A NEW REGGE POLE-CUT MODEL. Garfinkel, A. F. (Purdue Univ., Lafayette, Ind.); Vasavada, Kashyap V. (Indiana-Purdue Univ., Indianapolis). 1972. 11p. Dep. NTIS.

A fit was obtained to most of the available data on pion-nucleon charge exchange scattering using a new Regge pole-cut model. This shows quantitatively the importance of the double Regge cuts, as opposed to the Regge-Pomeron cuts. (auth)

54325 (COO-3533-2) PION AND K MESON PRODUCTION IN THE MULTIPERIPHERAL MODEL. Amann, R. F. (Syracuse Univ., N. Y. Dept. of Physics). Jun 1972. 24p. (SU-4205-2). Dep. NTIS.

A simple multiperipheral model that utilizes only three parameters, two coupling constants and an exponential damping for each momentum transfer, is developed and applied to the calculation of inclusive distributions. The pion rapidity and p^2 distributions are successfully predicted, as are the energy dependences of strange particle production cross sections. The development of inclusive distributions with increasing energy and possible improvements to the model are discussed. (4 figures, 2 tables) (auth)

54326 (DESY-72/40) LIMITING DISTRIBUTIONS FOR INCLUSIVE CHARGED PION PRODUCTION AT VERY HIGH ENERGY. Meyer, H.; Struczinski, W. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Jul 1972. 8p. Dep. NTIS (U. S. Sales Only).

A conjecture is given, of how limiting distributions are approached in the target fragmentation region and in the central region, for inclusive charged pion production. (auth)

54327 (JINR-E2-6596) MULTIPLE CHARGED PARTICLE PRODUCTION IN π^-p AND π^-n INTERACTIONS AT p = 40 GeV/c. Grishin, V. G.; Jancso, G.; Kuleshov, S. P.; Matveev, V. A.; Sisakyan, A. N. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1972. 11p. Dep. NTIS (U. S. Sales Only).

A model is suggested for a common description of multiple charged particle production in π^-p and π^-n interactions. Comparison of the model with experimental data at pc = 40 GeV gives good agreement. The value for an average number of produced $\pi^+\pi^-$ meson pairs ($a = 1.81 \pm 0.02$) as well as the coefficient of the nucleon charge exchange ($\beta = 0.36 \pm 0.04$) are determined. The identity of the distribution of events over the charged secondary particles, e.g., for π^+p and π^-p; pp and $p\bar{p}$ collisions, is predicted. (auth)

54328 (LBL-544) PARTIAL WAVE ANALYSIS OF THE REACTION $\pi N \to N\pi\pi$ IN THE CMS ENERGY RANGE 1.6 GeV TO 2.0 GeV. Herndon, David J. (California Univ., Berkeley. Lawrence Berkeley Lab.). 30 May 1972. Contract W-7405-eng-48. 95p. Dep. NTIS.

Thesis.

The results of an energy-independent partial-wave analysis of the single-pion production reactions at nine center of mass energies from 1.6 to 2.0 GeV are presented. This maximum likelihood analysis was based upon the isobar model. The results of a preliminary K-matrix analysis are used to remove the overall phase ambiguity at each of the energies. The Argand plots confirm the S11(2100) and P13(1850) resonances and show no evidence for the P31(1900) in the channels. There are indications of the existence of the D13(1700), badly needed by the quark model, and for a new P11 resonance around 2100 MeV. (auth)

54329 (NYO-3533-265) INTERFERENCE TERMS IN THE MULTIPERIPHERAL MODEL. Amann, R. F.; Shah, Prakash M. (Syracuse Univ., N. Y. Dept. of Physics). May 1972. 11p. (SU-4205-265). Dep. NTIS.

The customary assumption of the neglect of interference or crossed graph terms is investigated within a simple multiperipheral model and found to be completely unjustified. The inclusion of these terms, in a multi-Regge model, allows the correct prediction of the ratio of Kp to πp cross sections and of the energy dependences of inelastic cross sections and pion multiplicities. A natural explanation is provided for dramatic structures observed in correlation functions. (auth)

54330 DESCRIPTION FOR THE REACTIONS $a + b \to c + d + e$. Cashmore, R. J. (Stanford Univ., Calif.); Hey, A. J. G. Phys. Rev., D; 6: No. 5, 1303-13(1 Sep 1972).

A formalism for describing the reactions $a + b \to c + d + e$ is presented in detail and the experiments necessary for the reconstruction of the transition amplitude described. Experiments involving polarized targets are discussed carefully and a partial-wave analysis is made which is particularly suitable for application at low c.m. energies. It is shown that in order to resolve parity ambiguities it is necessary to observe the final particle polarizations. (auth)

54331 BACKWARD-SCATTERING EXTRAPOLATIONS AND BARYON COUPLINGS. Roy, D. P.; Roberts, R. G.; Phillips,

R. J. N.; Miettinen, H. I. (Rutherford High Energy Lab., Chilton, Eng.). Phys. Rev., D; 6: No. 5, 1317-21(1 Sep 1972).

Extrapolation of an asymptotic cross section to a baryon pole cannot uniquely determine the coupling constant. The only asymptotic quantities capable of doing this are the R and A parameters. The notorious discrepancy between extrapolation of $d\sigma(\pi^-p)/du$ and the known Δ width is shown to be purely illusory. (auth)

54332 PHENOMENOLOGY OF THE TRIPLE-REGGE REGION. Ellis, S. D.; Sanda, A. I. (National Accelerator Lab., Batavia, Ill.). Phys. Rev., D; 6: No. 5, 1347-50(1 Sep 1972).

A two-term triple-Regge formula, which follows from a simple theoretical picture of the single-particle inclusive cross section, is presented and studied. A comparison is made with recent data for $pp \to p$ + anything, and $p\pi^- \to p$ + anything. The description of the data offered by this simple form is found to be remarkably good over a large region of phase space. (auth)

54333 BARYONIC INTERACTIONS IN AN EFFECTIVE-LAGRANGIAN MODEL. Bhargava, Ashok Kumar (Indian Inst. of Tech., Kanpur). Phys. Rev., D; 6: No. 5, 1453-5 (1 Sep 1972).

An effective Lagrangian for the study of strong interactions of $\frac{1}{2}^+$ baryons with spin-one and spin-zero mesons is constructed. Expressions for masses, coupling constants, and weak decay constants for the leptonic decays of baryons are obtained. Predictions of the model are compared with the experimental data. (auth)

54334 POSSIBLE STUDY OF BOUND $\bar{p}n$ STATES IN EXPERIMENTS ON THE ANNIHILATION OF $\bar{p}$ ON d. Bogdanova, L. N.; Dal'karov, O. D.; Shapiro, I. S. (Inst. of Theoretical and Experimental Physics, Moscow). JETP Lett. (USSR) (Eng. Transl.); 15: No. 12, 531-3(20 Jun 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 15: No. 12, 748-51(20 Jun 1972).

The theoretically expected form of the momentum spectrum of the recoil protons in the reaction $\bar{p} + d \to p$ + anything is studied for different energies. The analysis shows that a study of the spectra for different recoil-proton spectra emission angles makes it possible to determine experimentally the nonzero orbital momenta of the bound states of $\bar{p}$ and n. (J.F.P.)

54335 REACTIONS OF SINGLE Σ- AND Λ-HYPERON PRODUCTION. Nikolaev, N. N. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz.; 15: No. 6, 1243-50 (Jun 1972). (In Russian).

Single Σ- and Λ-hyperon production in reactions $\pi N \to \pi\Sigma(\Lambda)$ near the reaction threshold is discussed. Cross sections and polarization phenomena are predicted using PCAC. (auth)

54336 NEW REGGE ABSORPTION MODEL. Thews, R. L. (Univ. of Arizona, Tucson); Goldstein, Gary R.; Owens III, Joseph F. Nucl. Phys.; B46: No. 2, 557-67(1972).

The weak-cut Regge absorption model is generalized to allow for unequal absorption of the rotating ($e^{-i\pi\alpha}$) and non-rotating (1) parts of the Regge-pole exchange amplitude. Some justification for this procedure is given in terms of duality and peripheral resonance dominance. Fits to data for πN charge-exchange cross section and polarization and cross sections for the line-reversed hypercharge-exchange reactions $\bar{K}N \to \pi\Sigma$ and $\pi N \to K\Sigma$ are obtained. (auth)

54337 TESTING OF ANALYTICITY OF THE πN FORWARD SCATTERING AMPLITUDE AND THE DETERMINATION OF THE πN COUPLING CONSTANT. Pazman, A. (Inst. for Measurement Theory, Bratislava); Pisut, J.; Presnajder, P.; Lichard, P. Nucl. Phys.; B46: No. 2, 637-43(1972).

A new method is proposed for the testing of analyticity. Instead of using dispersion relations with traditional uncertainties in estimating the errors of the principal value integrals a suitably defined set of moments is used. As an example the pion-nucleon CEX forward amplitude is discussed. The results indicate that the errors of the phase shift analysis used should probably be increased by a factor of two. Taking this into account the pion-nucleon coupling constant is calculated by analytic extrapolation and $f^2 = 0.0835 \pm 0.0040$ is found. (auth)

54338 POSSIBLE CORRELATIONS AMONG BARYON TRAJECTORIES. Ida, M. (Kyoto Univ.). Lett. Nuovo Cim.; 4: No. 14, 707-10(5 Aug 1972).

Some regularities exhibited by baryon resonances of small spin are pointed out and the possibility that they have non-degenerate parity partners is discussed. The existence of first-daughter trajectories which are not parallel to partners is suggested. The exchange degenerate patterns of baryon trajectories are studied by considering the backward scattering of pseudoscalar-meson octets off baryon octets. (L.B.S.)

54339 LOW-ENERGY πN SCATTERING IN A CURRENT ALGEBRA MODEL WITH PHYSICAL PIONS. Radutskii, G. M.; Tabachenko, A. N. (Tomsk Polytechnical Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 1, 63-71(1972). (In Russian).

In models of current algebra with physical pions scattering and the energy dependence of S- and P-phase πN scattering were calculated. The results agreed with experimental data at low energies. (tr-auth).

54340 INEQUALITIES WITH πN POLARIZATION. Sakmar, I. A. (Univ. of Western Ontario, London). Progr. Theor. Phys. (Kyoto); 48: No. 1, 235-46(Jul 1972).

πN polarization is investigated as a function of the relative magnitude and relative phase of the spin-non-flip and spin-flip amplitudes. Inequalities for the magnitude and phase in terms of the polarization are obtained and physical implications are discussed. From Schwartz's inequality relations involving the polarization in integrated forms are obtained. (auth)

54341 COMMUTATION OF AXIAL CHARGES WITH AXIAL DIVERGENCES. Kaushal, V. (Panjab Univ., Chandigarh, India). Progr. Theor. Phys. (Kyoto) 48: No. 1, 357-9(Jul 1972).

The baryon decuplet contribution to the sum rules obtained using the commutator between axial charge and axial divergence and by taking the matrix elements between two sets of baryon states (Σ^+,Σ^+) and (Σ^0,Σ^0) are calculated, and it is shown that the contribution is not small. Another commutator is considered in which the right-hand side is the sum of two different components of the scalar density octet, and it is found that in general sensible results are not obtained in the saturation approximation. (L.B.S.)

54342 SYSTEMATIC STRUCTURE IN HADRONIC TWO-BODY SCATTERING AND RESONANCE CORRELATION. III. HADRON REACTIONS AND URBARYON REARRANGEMENT. Ghoroku, Kazuo (Kyushu Univ., Fukuoka); Imachi, Masahiro; Otsuki, Shoichiro; Toyoda, Fumihiko. Progr. Theor. Phys. (Kyoto); 48: No. 1, 210-30(Jul 1972).

Elastic and inelastic two-body (πN, KN, $\bar{K}N$, NN, and $\bar{N}N$) scattering is investigated by using the following amplitude corresponding to the pattern of the urbaryon rearrangement diagram: the H-type (s-t dual) amplitude $f^H_{\Delta\lambda} \sim iJ_{\Delta\lambda}(b_0\sqrt{-t}) - J_{\Delta\lambda+1}(b_0\sqrt{-t})$ and the X-type (t-u dual) amplitude $f^X_{\Delta\lambda} \sim -\{J^2_{\Delta\lambda}(b_0\sqrt{-t}) + J^2_{\Delta\lambda+1}(b_0\sqrt{-t})\}^{\frac{1}{2}}$ where $\Delta\lambda$ denotes the helicity change. These forms come from the effective resonance, or the resonance correlation subject to generalized Ogawa's rule of a constant impact parameter b_0. Two degrees of freedom of the counting scheme of the urbaryon rearrangement diagram in the framework of SU(3) symmetry are combined with the helicity change in the way suggested from a duality interpretation of the urbaryon rearrangement diagram. This counting scheme together with the above forms of the amplitude of the Bessel type offers a satisfactory over-all agreement with experiment in a forward region $-t \lesssim 2$ GeV^2. The value of b_0 is found to be 4.5/GeV for meson-baryon scattering and 5.5/GeV for NN and $\bar{N}N$ scattering. (auth)

Strong (Baryon No. ≥ 2)

Refer also to abstracts 54520 and 54532.

54343 (DESY-72/35) ANOMALOUS DIMENSIONS IN p-p ELASTIC SCATTERING? Theis, W. R. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Jul 1972. 11p. Dep. NTIS (U. S. Sales Only).

The concept of anomalous dimensions is used to connect high energy, large angle elastic p-p scattering with the high momentum behavior of the proton electromagnetic form factor consistent with the existing data. (auth)

54344 (ITF-72-10-P) SOLUTIONS OF THE SKORNYAKOV-TER-MARTIROSYAN EQUATIONS FOR THREE NUCLEONS WITH CUT-OFF AT LARGE MOMENTA. Kharchenko, V. F. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1972. 11p. (In Russian). Dep. NTIS (U. S. Sales Only).

The consistency of three-nucleon low-energy parameters in the doublet spin state is investigated on the basis of the Skornyakov-Ter-Martirosyan equations with cutoff at large momenta. The deuteron binding energy and the singlet n-p scattering length are used as two-nucleon parameters. The cut-off parameter introduced is determined by fitting the triton binding energy. The calculations in this way give a value for the doublet n-d scattering length in agreement with the experimental results obtained by Hurst and Alcock and by Dilig, Koester, and Nistler. (2 figures) (auth)

54345 (JINR-P4-6505) FACTORIZATION OF THE PAIR POTENTIAL BY THE BATEMAN MODIFIED METHOD IN THE TWO- AND THREE-BODY PROBLEM. Belyaev, V. B.; Zubarev, A. L.; Irgaziev, B. F. (Joint Inst. for Nuclear Research Dubna (USSR). Lab. of Theoretical Physics). 1972. 13p. (In Russian). Dep. NTIS (U. S. Sales Only).

The factorization of the Fourier-image of the pair short-range

potential $v(k,k')$ by the expression $\overline{\overline{v}}^{N}(k,k') = \Sigma_{i,j}(d^{-1})_{ij}v(k,s_i)v(k',s_j)$, where one of the fixed parameters s_i is replaced by the value equal to the energy of considered two-particle system is suggested. Such a replacement improves considerably the behavior of the approximated phases of the nucleon-nucleon scattering and turns out to be especially useful when solving the Faddeev equations. (auth)

54346 (RPP/T-28) SIMPLE EXPLANATION OF CORRELATION DATA IN INCLUSIVE pp INTERACTIONS AT HIGH ENERGY. Fialkowski, K. (Rutherford High Energy Lab., Chilton (England)). 1972. 10p. Dep. NTIS (U. S. Sales Only).

The existing integral and differential data for two-particle correlations between negative pions produced in high energy pp collisions are discussed. They are shown to be explained in a simple way by adopting the Feynman–Wilson two-component picture. The diffractive part of the distribution, which appears to be small, is evaluated from experimental data. For the nondiffractive interaction the conservation laws are assumed to play the dominant role in correlation effects. (auth)

54347 (UM-P-72-6) ANALYSIS OF BREAKUP SCATTERING IN A DEUTERIUM TARGET. APPLICATION TO ANTIPROTON–DEUTERON BREAKUP SCATTERING. MacDowell, C. E.; Opta, Geoffrey I. (Melbourne Univ., Parkville (Australia). School of Physics). 1972. 31p. Dep. NTIS (U. S. Sales Only).

The problems of extracting low momentum transfer cross sections for the "elastic" scattering of a projectile particle by the "neutron" in a deuterium target are discussed for the case in which the deuteron breaks up. The difficulties in the analysis of deuterium events due to the Fermi motion are discussed. Further, the influence of the final-state neutron-proton interaction is presented in detail. Application is made to the reaction $\bar{p}d \rightarrow \bar{p}pn$. (auth)

54348 DAMPED PSEUDOSCALAR- AND VECTOR-MESON MODEL FOR NUCLEON–NUCLEON SCATTERING. Bock, Charles W.; Haracz, Richard D. (Drexel Univ., Philadelphia). Phys. Rev., D; 6: No. 5, 1373-8(1 Sep 1972).

Recently, a pseudoscalar–vector-meson (PV) model for elastic nucleon–nucleon scattering was presented by Barker and Haracz in which phase parameters are defined by a perturbative method which is similar to the geometric unitarization scheme used in other models. These phase parameters are dominated by the two-pion-exchange (TPE) contribution for the low values of L, and TPE is unreasonably large for the phases associated with the S state. In order to suppress this large contribution, relativistic Heitler damping or K-matrix unitarization is applied to the PV model. It is found that the low-partial-wave phase parameters ${}^{1}K_0^S$, ${}^{3}\theta_1^S$, ${}^{3}\theta_1^D$, and ρ_1 are drastically reduced and made much more reasonable by damping. Moreover, the P- and D-state phase shifts are reduced by as much as 20% at the higher scattering energies. The resulting damped phase parameters are in good agreement with the phenomenological values for $L \geq 2$ and energies up to 200 MeV, excluding ${}^{3}\theta_1^D$. Coupling constants more consistent with experiment are used contrasting with our previous usage. It is also found that the presence of a strongly coupled scalar ϵ resonance does not improve this model. (auth)

54349 BOSE DISTRIBUTION AND SCALING LAW. Hoang, T. F. (Argonne National Lab., Ill.). Phys. Rev., D; 6: No. 5, 1328-32(1 Sep 1972).

Properties of a two-parameter Bose-type distribution were investigated using data on π and K mesons of inclusive p-p collisions from 12 to 30 GeV/c. It is found that the temperature T is characteristic of the particle emission: $T_\pi > T_K$, and T for π^- is about 5 MeV higher than that of π^+. The scaling behavior is found to hold for both π and K for incident lab momentum above 20 GeV/c. (auth)

54350 DAMPED THEORY OF NUCLEON–NUCLEON SCATTERING. Bock, Charles Walter. Philadelphia; Drexel Univ. (1972). 129p. University Microfilms Order No. 72-21,419.

Thesis.

An accurate determination of the effects of radiation damping on the nucleon–nucleon scattering amplitudes and phase parameters is established by solving exactly Gupta's covariant field-theoretic generalization of the Heitler integral equation. This is accomplished by using a partial wave projection technique developed by Jacob and Wick. Equations relating the damped and undamped scattering amplitudes are obtained, and their respective relations to the phase parameters are discussed. Explicit damped phase shifts are obtained for the one- plus two-pion-exchange (OPE + TPE) and pseudoscalar vector meson (PV) models of the nucleon–nucleon interaction. A comparison of the damped and undamped phase shifts shows that damping effects are significant for $L < 3$, and improve the theoretical phase shifts when compared to the Yale phenomenological values. (Diss. Abstr. Int., B)

54351 SHELL-MODEL ANALYSIS OF Λ BINDING ENERGIES FOR THE p-SHELL HYPERNUCLEI. II. NUMERICAL FITTING, INTERPRETATION, AND HYPERNUCLEAR PREDICTIONS. Gal, A. (Hebrew Univ., Jerusalem); Soper, J. M.; Dalitz, R. H. Ann. Phys. (N. Y.); 72: No. 2, 445-88(Aug 1972).

A phenomenological analysis of the Λ binding energies known for the p-shell hypernuclei is given in terms of their representation by the shell-model configuration $[(1s)_N^4(1p)_N^{A-5}(1s)_\Lambda]$, by using the formalism set up in Part I. The ΛN interactions are described quite generally by five free parameters, and the inclusion of ΛNN interactions with the forms arising through the double-OPE mechanism requires five further parameters. Various constraints motivated by theoretical arguments concerning the nature of ΛN and ΛNN interactions are imposed on these parameters, and best fits are then obtained for them by following a minimization procedure. A good and economical fit to these data is obtained for a parameter set in good accord with theoretical notions about these interactions (although the fit otherwise most attractive does require ΛN spin–orbit forces with sign opposite those known for the NN system). On the basis of these fits to the B_Λ data, a discussion is given of the energy-level spectra for the p-shell hypernuclei, of isomeric states for ${}^{7}_{\Lambda}\mathrm{He}^*$ and ${}^{7}_{\Lambda}\mathrm{Li}^*$, and of the resulting predictions for the properties of the Λ hypernuclei corresponding to core nuclei assigned to the $p_{\frac{1}{2}}$ shell. (4 figures, 9 tables) (auth)

54352 RECOIL AND FRESNEL CORRECTIONS TO SCATTERING BY THE DEUTERON. Faeldt, Goeran (SIN, Zurich). Nucl. Phys.; B46: No. 2, 460-6(1972).

It is shown how both recoil and Fresnel corrections can be obtained from a careful treatment of the double scattering term in the Watson multiple-scattering series. (auth)

54353 COMMENTS ON ARNOLD AND BARNETT'S SHIELDING-CUT MECHANISM. II. Fujisaki, Haruo (Rikkyo Univ., Tokyo). Progr. Theor. Phys. (Kyoto); 48: No. 1, 231-4(Jul 1972).

Brief comments are given at extremely high energies on the fixed-pole Pomeron with two Arnold and Barnett's shielding branch-cuts, i.e., $\overline{\alpha}_C(t)$ of $\overline{\alpha}_C(4m_\pi^2) = 1$ and $\tilde{\alpha}_C(t)$ of $\tilde{\alpha}_C(4m_K^2) = 1$. Assuming that the Pomeronia has already been attained at the CERN-ISR energy ranges, it is also argued in the case of proton-proton collision that asymptotic values of the total cross section and the slope parameter of the diffraction peak are 59.9 mb and 14.6 GeV^{-2}, respectively. (auth)

54354 SCALING OF INTERACTION RADIUS AND POLARIZATION. Otsuki, Shoichiro (Kyushu Univ., Fukuoka). Progr. Theor. Phys. (Kyoto); 48: No. 1, 347-8(Jul 1972).

New evidence for the hypothesis of interaction radius scaling is obtained by analyzing precise polarization data on elastic pp, K^+p, $\bar{p}p$, and K^-p scattering between 6 and 14 GeV/c. (L.B.S.)

Particle Invariance Principles and Symmetries

General

54355 (ITF-72-33-E) WIGNER–ECKART THEOREM FOR NONUNITARY REPRESENTATIONS OF SEMI-SIMPLE LIE GROUPS. CONTINUUM CASE. Klimyk, A. U. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1972. 17p. Dep. NTIS (U. S. Sales Only).

An analog of the Wigner–Eckart theorem is proved for the tensor operators with transform according to the finite-dimensional representation of a semi-simple group when the Hilbert space is decomposed into the direct integral of representations spaces of the group under consideration. The question is considered concerning the application of the theorem proved for the construction of invariant wave equations and representations of the Lie group. As a result, the relativistic invariant wave equations which are absent in the Gelfand–Yaglom classification of such equations are obtained. (auth)

54356 ONE PARTICLE SINGULARITIES AND PHYSICAL SYMMETRIES. Fabricius, K. (Univ. of Bielefeld, Ger.). Nucl. Phys.; B46: No. 2, 467-76(1972).

It is shown that a physical symmetry is completely determined by the one-particle singularities of current matrix elements. (auth)

54357 ASYMPTOTICALLY FLAT SPACE-TIMES AND ELEMENTARY PARTICLES. McCarthy, Patrick J. (Univ. of British Columbia, Vancouver). Phys. Rev. Lett.; 29: No. 12, 817-19 (18 Sep 1972).

It is suggested that elementary particles should be defined as irreducible unitary representations of the group of asymptotically flat space-times in general relativity. The implications of such a definition are described in physical terms. In particular, it is pointed out that this definition (unlike the corresponding "flat

space–time" definition) explains the observed discreteness of elementary-particle spins. The possibility of using the definition to explain "internal" symmetries is discussed. (auth)

54358 RESULT BY R. KADISON AND J. RINGROSE. Bulinskii, A. V. (Moscow Physical-Technical Inst.). Teor. Mat. Fiz.; 12: No. 2, 197-203(Aug 1972). (In Russian).

For compact Lie groups of automorphisms of a C*-algebra continuity in the norm topology implies covariance of representations of the algebra. (auth)

54359 LORENTZ-COVARIANT BILINEAR FORMS. Oksak, A. I. Teor. Mat. Fiz.; 12: No. 2, 179-96(Aug 1972). (In Russian).

Convariant bilinear forms and covariant operators over spaces transforming under infinite-dimensional and, more generally, elementary representations of the connected Lorentz group are described in the manifestly covariant formalism. (auth)

54360 STATISTICAL MODEL WHICH ALLOWS FOR THE CONSERVATION OF P-, C-, AND G-PARITY. Gridneva, S. A.; Kosmachev, O. S.; Rus'kin, V. I. Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat.; No. 4, 29-34(Jul-Aug 1971). (In Russian).

A new variant of a statistical model is presented, which considers the laws of conservation of P-, G-, and C-parity. (tr-auth)

Applications (Electromagnetic and Weak)

Refer also to abstract 54188.

54361 (COO–1195-242) COMPARISON OF CP VIOLATION IN THE DECAYS $K^0 \to \pi^+\pi^-$ AND $\overline{K}^0 \to \pi^+\pi^-$. Raither, Siegbert Wilhelm (Illinois Univ., Urbana). Oct 1972. Contract AT(11-1)-1195. 96p. Dep. NTIS.

Thesis.

The time dependence of the decay rates $K^0 \to \pi^+\pi^-$ and $\overline{K}^0 \to \pi^+\pi^-$ was measured in order to test the validity of current formulations of CP violations. An enriched kaon beam at Argonne National Laboratory was used to produce K^0 ($\overline{K}^0$) by charge exchange of 850 MeV/c K^+ (K^-) on complex nuclei. Magnetostrictive wire spark chambers and scintillation counters were used to measure the $\pi^+\pi^-$ rates in the interval from four to twelve K_S^0 lifetimes. The time distributions of these decay rates agree with those expected from prevalent theories of CP violation. (auth)

54362 (COO–1195-244) TIME DECAY DISTRIBUTIONS OF $\overline{K}^0$ AND K^0 TO $\pi^+\pi^-$: A CP TEST. Frank, James Sidney (Illinois Univ., Urbana). Oct 1972. 96p. Dep. NTIS.

Thesis.

A direct comparison of the time decay distributions of $\overline{K}^0$ and K^0 to $\pi^+\pi^-$ was made at the Argonne National Laboratory Zero Gradient Synchrotron. The neutral kaons were produced by charge exchange of 850-MeV/c charged kaons on a carbon target. Their subsequent decays were tracked with magnetostrictive wire spark chambers in the range from 4 to 12 K_S lifetimes. No magnetic analysis was required in order to analyze the kinematics of each event. A 3.5 standard deviation effect was found for direct evidence of CP violation. This is independent of any theoretical decay formalism. Also good agreement was found with the usual formalism of CP violation in the $\pi^+\pi^-$ decay mode of the neutral kaon system. This is the first time that CP violation was observed in $\overline{K}^0$ decay. (auth)

54363 (IS-T–536) CONTRIBUTIONS OF TIME-REVERSAL NONINVARIANT TERMS IN ELECTRON–NUCLEUS ELASTIC SCATTERING. Krase, Loren Dell (Ames Lab., Iowa). Aug 1972. Contract W-7405-eng-82. 83p. Dep. NTIS.

Thesis.

The possibility of using elastic scattering of electrons from nuclei having spin one or greater to search for T noninvariant effects in electromagnetic processes was investigated. In the one photon exchange approximation of the elastic scattering process, terms which are invariant under P and PCT but noninvariant under T may be explicitly included in the nuclear current for the interaction of these nuclei. The transformation properties of the various terms which may contribute to the current were developed and discussed within a manifestly covariant framework. The current was then specialized to a noncovariant form in the Breit (or brick-wall) frame of the nucleus where the physical form factors of the nuclear current were easily identified. This noncovariant form was then used to determine tests which could be used to search for T noninvariant effects. Two restrictions were placed on the types of experimental tests which could be made: since the polarization tensors of large rank can be produced only with a large momentum transfer, or emission or absorption of radiation of large multipolarity, the polarization tensors were taken to be, at most, second rank; to ensure that the results would be as statistically accurate as possible, the measurable quantities were taken to be the cross sections and the electron beam polarizations. Within these restrictions, at least two types of tests are possible. If the nuclear target is completely described by a vector polarization only, with a component normal to the scattering plane, the cross section for the scattering of unpolarized electrons has an asymmetry if the electromagnetic interaction is noninvariant under T. If the nuclear target is completely described by a second rank tensor only, with components in the scattering plane, an initially unpolarized electron beam has a polarization after the scattering if the electromagnetic interaction is noninvariant under T. These tests, however, are not completely unambiguous. The polarization tensors of other rank may give a contribution which is not zero even when the electromagnetic interaction is invariant under T. In addition, the higher order processes may give a nonzero contribution even when the interaction is T invariant, as is demonstrated for the test involving the asymmetry in the cross section. (auth)

54364 (NYO–3533-264) UNIFIED WEAK-ELECTROMAGNETIC GAUGE SCHEMES BASED ON THE THREE DIMENSIONAL UNITARY GROUP. Schechter, J.; Ueda, Y. (Syracuse Univ., N. Y. Dept. of Physics). May 1972. 20p. (SU–4205-264). Dep. NTIS.

SU(3) × U(1) and chiral SU(3) × SU(3) × U(1) × U(1) models for the weak and electromagnetic interactions of leptons and hadrons are proposed. The usual quark model for hadrons as well as the usual Cabibbo rotation scheme is assumed. Symmetry breaking effects due to inequalities in the masses of the gauge bosons are considered. By making a simple choice of the gauge boson masses based on the U-spin subgroup of SU(3), the undesired $|\Delta S| = 2$ weak nonleptonic transitions can be completely eliminated and the undesired $|\Delta S| = 1$ neutral current semi-leptonic transitions drastically suppressed. These models can reproduce the ordinary phenomenological weak interaction but are sufficiently flexible to give the possibility of interesting new effects for neutral leptonic and semi-leptonic processes, as well as to allow the possibility of an overall arbitrariness in normalization for the effective nonleptonic interaction. Another consequence of the present scheme is the existence of very heavy leptons. A brief discussion of including the strong interactions in a grand unification is also presented. (auth)

54365 WEAK RADIATIVE DECAYS OF K MESONS. Moshe, M.; Singer, P. (Technion-Israel Inst. of Tech., Haifa, Israel). Phys. Rev., D; 6: No. 5, 1379-92(1 Sep 1972).

The possibility of a unified description for several weak radiative decays of K mesons is being investigated. In particular, those processes are considered in which the decay mechanism can be related to the strong (or electromagnetic) PVV vertex, namely $K^+ \to e^+\nu\gamma$, $K_2^0 \to \pi^+\pi^-\gamma$, and $K^+ \to \pi^+\gamma\gamma$, in addition to the process $K_2^0 \to \gamma\gamma$, which was treated before. Vector gauge fields with current mixing and octet breaking in the PVV vertex are used, as indicated from a phenomenological Lagrangian model fitting the data on strong and radiative meson decays. For the weak nonleptonic interaction two alternatives were considered, the current-current "simplest" Hamiltonian suggested recently in connection with $K_2^0 \to \gamma\gamma$ decay, as well as the current-current octet Hamiltonian in the form introduced by Sakurai, both satisfying the $\Delta S = 1$, $\Delta I = \frac{1}{2}$ rule. The experimental upper limit on $K^+ \to e^+\nu\gamma$ imposes limits on a free parameter of the theory related to the SU(3) symmetry breaking in the PVV vertex. Within these limits the width for $K_2^0 \to \pi^+\pi^-\gamma$ is calculated, which differs considerably from the SU(3)-symmetric value and is predicted to be close to the present experimental upper limit. In the calculation of $K^+ \to \pi^+\gamma\gamma$ a new class of diagrams is considered which appear because of the use of vector gauge fields in the Lagrangian. These diagrams involving four-leg vertices are shown to give the dominant contribution to the decay. The calculated rate and spectrum differ from those of previous calculations. (auth)

54366 TIME REVERSAL FOR UNSTABLE PARTICLES. Schulman, L. S. (Indiana Univ., Bloomington). Ann. Phys. (N. Y.); 72: No. 2, 489-96(Aug 1972).

The time reversal operator (T) for unstable particles is defined such that the fact of decay of the particle is not mistaken for a dynamical violation of T in the decay. This definition is not valid where the medium in which the decay takes place may have its own intrinsic T violation. Based on this limitation, some effort is made to restrict the conclusions drawn from apparent T violation in K-meson decay. (1 figure) (auth)

54367 CP-VIOLATING GAUGE INTERACTIONS. Isham, C. J. (Imperial Coll. of Science and Tech., London); Salam, A.; Stratdhee, J. Lett. Nuovo Cim.; 4: No. 14, 678-80(5 Aug 1972).

An attempt is made to derive an Okubo-like Lagrangian using the gauge principle, which yields (a) vector-type interactions, (b) universality, and (c) restrictions on the possible interaction types. The natural violation of C or (CP) which arises from gauging kinetic-energy vs. surface terms is demonstrated. (L.B.S.)

54368 RELATIVISTIC EQUATION FOR BARYONS OF A 45-DIMENSIONAL REPRESENTATION OF SCHWINGER GROUPS W(3). PART 2. Masleev, N. N. Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat.; No. 4, 12-19(Jul-Aug 1971). (In Russian).

Electromagnetic interactions of baryons $\frac{1}{2}^+$ were investigated on the basis of the results obtained in Part 1. The representations of Schwinger relativistic groups, relative to the baryons investigated, were examined. Combining two reducible representations of groups SU(3) × SL(4), good values for the magnetic moments may be obtained, which do not contradict Fermi statistics, by using integral charges for the fundamental fields. (tr-auth)

54369 LOWER BOUND FOR CP-NONCONSERVATION IN THE $K_{L,S}^0$ DECAY INTO $\mu^+\mu^-$. Shirafuji, Tadahiko (Chiba Univ., Japan). Progr. Theor. Phys. (Kyoto); 48: No. 1, 337-9(Jul 1972).

The inequality $[\text{Rate}\ (K_L^0 \to \mu^+\mu^-)]^{1/2} < (\text{Re}\,\epsilon)\ [\text{Rate}\ (K_S^0 \to \mu^+\mu^-)]^{1/2}$ was obtained by Christ and Lee on the assumptions that (1) the absorptive part of the $K_L^0 \to 2\gamma$ decay amplitude is zero, (ii) the absorptive part of the $K_L^0 \to \mu^+\mu^-$ decay amplitude is due only to the on-mass-shell 2γ intermediate state, and (iii) both CPT-invariance and quantum electrodynamics are valid, but CP conservation is not, and using the experimental upper bound on the branching ratio. Several consequences from this inequality are discussed: contradiction with super weak theory; and the lower bound for CP nonconservation. (L.B.S.)

Applications (Strong)

Refer also to abstract 54309.

54370 (NP-19418) REPRESENTATION OF SU(3) x SU(3) CHIRAL ALGEBRA FOR BARYONS. Note No. 369. Buccella, F.; Nicolo, F.; Pugliese, A. (Rome Univ. (Italy). Istituto di Fisica). 6 Apr 1972. 17p. Dep. NTIS (U. S Sales Only).

A mixing operator U(Z') for baryons, which transforms the SU(6) axial charges in a more realistic set satisfying at the same time the equations: $(\sigma_5^0, \sigma_5^0) = 1\ f^{\alpha\beta\gamma}\sigma^\gamma$ and $[\sigma_5^+, (\sigma_5^+, m^2)] = 0$, is presented. The (56 ⊕ 70, any L) SU(6) ⊗ O(3) representations are considered to obtain a consistent result. The octet chiral wave function comes out in good agreement with experimental data and the coupling constants between the (56, L = 0) and any other representation with arbitrary L correspond exactly in a dual sense to the exchange in the t-channel of a tensor nonet and a vector octet with the couplings proposed by Cabibbo, Horwitz and Ne'eman. The explicit form of the m^2 operator is given. (auth)

54371 CHIRAL TENSORS AND THE AXIAL CHARGE. Vasholz, David P. (Univ. of Florida, Gainesville). Phys. Rev., D; 6: No. 5, 1322-4(1 Sep 1972).

Tensors which transform according to the (1,8) representation of SU(3) ⊗ SU(3) and whose commutators with axial charges are to good approximation saturated by octet and decuplet intermediate states are investigated. The mere existence of such operators is sufficient to impose a constraint between g_s and g_a, the symmetric and antisymmetric axial-charge-baryon-octet couplings. When this constraint is plotted in the $g_s - g_a$ plane, the resulting graph passes remarkably close to the experimental point. Using the experimental value of g_A as an input, the constraint predicts an axial-charge D/F ratio of 2.12 ± 0.03. (auth)

54372 RELATIVISTIC EQUATION FOR BARYONS OF A 45-DIMENSIONAL REPRESENTATION OF SCHWINGER GROUPS W(3). PART I. Masleev, N. N. Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat.; No. 4, 5-12(Jul-Aug 1971). (In Russian).

It was proposed that baryons, corresponding to a 45-dimensional representation of Schwinger groups, consist of four particles, three of which are fermions with a spin of $\frac{1}{2}$, and one a boson with a spin of one. An interaction matrix of a special type was introduced into the equation of the four particles, and during the transition to a limit, wherein the masses of the composite baryons tend to approach infinity, an equation was obtained, which after transition to suitable variables and some additional conversions, was brought to a form which was applicable to a relativistic-invariant description of baryons in the free state and in the presence of a weak electromagnetic field. (tr-auth)

Field Theories

General

Refer also to abstract 55070.

54373 (ITF-72-35-P) ON THE EXTERNAL INVARIANT EQUATIONS OF ELECTROMAGNETIC FIELD. Zaitsev, G. A.; Solunin, A. M. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1972. 21p. (In Russian). Dep. NTIS (U. S. Sales Only).

The invariant properties of Maxwell equations are considered in the presence of electric and magnetic charges with respect to a group of external transformations. The variational principle is formulated and consequences of the external invariance of field equations are derived. (auth)

54374 SYMMETRY OF THE COULOMB FIELD AND ITS APPLICATIONS. Kulkarni, Ramesh G. Stillwater, Okla.; Oklahoma State Univ. (1971). 188p. University Microfilms Order No. 72-21,916.

Thesis.

The study of the symmetries of non-relativistic, relativistic, and approximate relativistic Coulomb problem is of value both in atomic and particle physics. The invariance and noninvariance group structure and associated generators would give a deep interpretation of the energy level spectra and certain selection rules in the multipole transitions. The structure of the basis functions for the irreducible representations in the complex spaces of the Fock–Bargmann type give a clear picture of the role played by the symmetry. The study of the Stark effect has received a renewed experimental interest. The experimental accuracies have improved by few orders of magnitude making it necessary to have a correct theoretical calculation of the Stark shifts. It is also interesting to study the effect of symmetry on the Coulomb field on the Stark shift calculations. The study shows that the symmetry of the Coulomb field explains vanishing of certain radial integrals involving multipole operators. It can also be used to evaluate some radial integrals in problems like Coulomb excitation. The symmetry shows that the parabolic and spherical wave functions of the nonrelativistic Coulomb field are connected through the Clebsch–Gordan theorem. The parabolic and spherical wave functions were obtained in Fock–Bargmann space and relation between them was established. The momentum space wave functions of the symmetric Hamiltonian were also discussed. The first order Stark shifts are calculated using Dirac wave functions, Pauli wave functions and relativistic symmetric wave functions. The shifts calculated on the basis of symmetric Hamiltonian are linear and spin dependent. For low values of electric field the experimental Stark shifts are quadratic and the discrepancy between the calculated first order shifts and the experimental values is large. For intermediate values of electric fields the shifts are linear. The agreement between theory and experiment is better. (Diss. Abstr. Int., B)

Quantum Field Theory

Refer also to abstract 54413.

54375 (COO-1811-3) MEASUREMENT OF THE LAMB-SHIFT IN A HYDROGEN-LIKE ATOM OF NUCLEAR CHARGE Z ≥ 3. Final Report. Fan, C. Y. (Arizona Univ., Tucson). 1972. Contract AT(11-1)-1811. 4p. Dep. NTIS.

The Lamb shift in $^{16}O^{7+}$ was measured in order to uncover some fundamental defect in quantum electrodynamics. The averaged Lamb shift calculated from the measured decay constants is 2215.6 ± 7.5 GHz. (J.F.P.)

54376 (ITF-72-15-E) EQUATIONS FOR THE S-MATRIX ELEMENT IN $g(:\phi^4:)_2$ THEORY. Ivanov, S. S. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1972. 14p. Dep. NTIS (U. S. Sales Only).

The equations for the S-matrix elements for the $g(:\phi^4:)_2$ theory in the Euclidean domain are considered. The existence theorem for the space-time cutoff equation is proved. It is shown that the perturbation series is asymptotic for an exact solution. (auth)

54377 (ITF-72-54-P) DISPERSION SUM RULES AND THE JOST-LEHMAN-DYSON REPRESENTATION IN AXIOMATIC QUANTUM THEORY. Zinov'ev, G. M.; Miranskii, V. A.; Shelest, V. P. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1972. 19p. (In Russian). Dep. NTIS (U. S. Sales Only).

The spectral Jost–Lehman–Dyson representation is used to determine the structure of dispersion sum rules and Ward identities in axiomatic quantum theory. (auth)

54378 (ITF-72-62-E) WIGHTMAN AXIOMS FOR THE CONCENTRATABLE FIELD AND RECONSTRUCTION THEOREM. I. GLOBAL PROPERTIES OF THE FIELD. Lomsadze, Yu. M.; Krivskii, I. Yu.; Shuba, I. M. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1972. 27p. Dep. NTIS (U. S. Sales Only).

The first steps are made in constructing the Wightman axiomatic approach for the so-called concentratable field $\hat{\varphi}(f)$. The concentratability of the additive functional $\hat{\varphi}(f)$ means that it belongs to one of maximum functional class concentratable, in rigorously defined sense, in any Borel set $\Delta \subseteq R_x^4$. Some general axioms and axioms about global properties of this field are formulated. Some algebraic constructions are given. (auth)

54379 COMPOSITENESS AND VANISHING OF RENORMALIZATION CONSTANTS. Passi, J. N. (Joint Inst. for Nuclear Research, Dubna, USSR). Nucl. Phys.; B46: No. 2, 497-504 (1972).

It is demonstrated within the framework of a model field theory that the vanishing of wavefunction and vertex-function renormalization constants is not a sufficient condition to make an elementary particle equivalent to a three particle bound state. It is noticed that the Jin–MacDowell cancellation for the three particle bound state does not hold good. (auth)

54380 VARIATIONAL PADE SOLUTION OF THE BETHE–SALPETER EQUATION. Alabiso, C.; Butera, P.; Prosperi, G. M. (Univ., Milan). Nucl. Phys.; B46: No. 2, 593-614(1972).

A variational Padé approximant technique for the calculation of the bound states, resonances and phase shifts is applied to the Bethe–Salpeter equation describing the interaction of two scalar particles in the ladder approximation. The main result is that the technique retains the very simple features and the fast convergence properties learned from a previous study of the potential scattering case. (auth)

54381 FEYNMAN RULES FOR MASSIVE GAUGE FIELDS WITH DUAL DIAGRAM TOPOLOGY. Gervais, J. L.; Neveu, A. (Laboratoire de Physique Theorique et Hautes Energy, Orsay, France). Nucl. Phys.; B46: No. 2, 381-401(1972).

The relationship of dual models with renormalizable theories of massive Yang–Mills fields of the type recently proposed by 't Hooft is studied through the zero slope. The field theoretic meaning of the twisting operator and the topology of dual models are clarified; these features result from the choice of a special non-Hermitian gauge condition in the underlying field theory. The local gauge invariance of that theory is the exact reflection of the first set of "gauge identities" appearing in the dual theory. In the non-Hermitian gauge, some renormalizable massive vector meson theories are both manifestly renormalizable, and this leads to a spectacular simplification of the Feynman rules. (auth)

54382 GENERALIZED FIELD THEORY AND FORM FACTORS OF NUCLEONS AND ATOMS. Riewe, Frederick Eugene. Gainesville, Fla.; Univ. of Florida (1971). 258p. University Microfilms Order No. 72-21,096.

Thesis.

Fields which obey equations containing derivatives of higher-than-usual order are the subject of generalized field theory. The use of such generalized fields results in a nonlocal theory which eliminates many of the infinities and divergences from quantum field theory. However, the theory is often considered to be unacceptable because of its many problems of physical interpretation. It is the purpose of the present investigation to develop a consistent interpretation of generalized field theory in terms of the internal structure of particles and then to apply the theory to realistic problems in nuclear and atomic physics. After briefly tracing the history of generalized field theory, the mathematical basis of the theory is developed in a classical context. The formalism is applied to the simple case of a classical point particle characterized by a Lagrangian which is a function of both velocity and acceleration. The theory leads directly to a description of a classical spinning particle. By placing the theory in canonical form and quantizing the Hamiltonian, one obtains a wave equation which, like the Dirac equation, is first order in time and manifestly covariant. Next, higher-derivative field equations are considered. The generalized quantum field theory is formulated in an indefinite metric space and applied to higher-derivative boson fields. These equations are physically interpreted as being the equations of a field exhibiting nonlocal interactions characterized by form factors. The form factor interpretation is shown to be mathematically consistent as well as to provide form factors which realistically describe known particles. The problem of determining the fundamental nuclear force is then discussed. The use of generalized fields is shown to be equivalent to the introduction of nucleon form factors, with the result that the two-nucleon potential is nonsingular. A generalized one-boson-exchange potential model is presented which accurately describes the nuclear force in terms only of known mesons. A second model is given in which charge independence is not assumed. Besides providing improved agreement with experimental data, the model indicates the extent of charge independence in the nuclear force. A third model of the two-nucleon force is presented which can be shown to accurately predict properties of finite nuclei. The use of generalized field theory as a mathematically equivalent substitute for the usual formalism used to describe atomic interactions is shown to have the practical consequence of characterizing atomic potentials by means of the same functions used in the nuclear-force problem, so that the same computational methods can be applied. In turn, the study of atomic processes provides a physical interpretation of infinite-order field equations in terms of charge-cloud polarization. The simplest form factor which includes charge-cloud polarization effects is shown to give a quantitative description of the electromagnetic structure of the proton. Thus the form factor interpretation of generalized field theory is satisfactory for field equations of both finite and infinite order. (Diss. Abstr. Int., B)

54383 N. N. BOGOLIUBOV'S TRANSFORMATION IN THE STRONG COUPLING THEORY. III. Solodovnikova, E. P.; Tavkhelidze, A. N.; Khrustalev, O. A. (Joint Inst. for Nuclear Research, Dubna, USSR). Teor. Mat. Fiz.; 12: No. 2, 164-78 (Aug 1972). (In Russian).

Translation invariant systems with strong couplings are considered. Application of N. N. Bogoliubov's transformation makes it possible to take explicitly into account the conservation laws, to construct the perturbation series with respect to a small parameter and to calculate the stationary states in the first approximation. The equidistant spectrum of the mass squared is obtained for the case of interaction of classical relativistic particles with an external field. (auth)

54384 PRODUCTION OF BOSON PAIRS BY STATIC FIELD. Arbusov, B. A.; Rochev, V. E. Teor. Mat. Fiz.; 12: No. 2, 204-8(Aug 1972). (In Russian).

Production of pairs of scalar particles by a square-well potential with smooth sides is considered. It is shown that the probability of the pair production in the threshold region includes an exponentially small factor depending on the degree of the "smoothness" of the potential well. (auth)

54385 TWO-DIMENSIONAL CLASSICALLY SOLVABLE MODEL WITH NONTRIVIAL SCATTERING. Pogrebkov, A. K. (Mathematics Inst., Moscow). Teor. Mat. Fiz.; 12: No. 2, 209-13(Aug 1972). (In Russian).

The model $(:j^{\mu}j_{\mu}\varphi:)_2$ describing the interaction of the massive scalar field φ with the massless spinor field is studied. It is shown that this model is explicitly solvable in the classical case and leads to nontrivial mutual transitions of the boson and fermion particles in the quantum case. (auth)

54386 HAMILTONIAN DEFINED AS A GRAPH LIMIT IN A SIMPLE SYSTEM WITH AN INFINITE RENORMALIZATION. Aoki, Masakazu; Mugibayashi, Nobumichi (Kagawa Univ., Takamatsu, Japan). Progr. Theor. Phys. (Kyoto); 48: No. 1, 281-9(Jul 1972).

The Hamiltonian of the neutral scalar field in interaction with a fixed source, when the infinite renormalization of vacuum energy is necessary, is defined by the graph limit of approximate Hamiltonians. Remarks are made on the asymptotic fields in this case. (auth)

54387 SPONTANEOUS BREAKDOWN OF SYMMETRY AND THE GAUGE INVARIANCE IN A RELATIVISTIC FIELD THEORY. Aurilia, Antonio (Univ. of Alberta, Edmonton) Takahashi, Yasushi; Umezawa, Hiroomi. Progr. Theor. Phys. (Kyoto); 48: No. 1, 290-315(Jul 1972).

The Nambu–Jona-Lasinio model in which the helicity current is coupled with a massless chiral gauge field, is discussed in the pair approximation. The model is invariant under the constant as well as local gauge transformations. The excitation spectrum of physical states is investigated in this model, under the requirement that the chiral gauge invariance is maintained at every stage. Symmetry breaking solutions are found in a noncovariant form. Contrary to previous assertions, massless fields are still present in the theory. Thus, the physical fields are a massive vector field, a massless vector field and a phase field. It is shown that the gauge transformations are carried by the phase field and the massless vector field, respectively. (auth)

54388 REMARKS ON SCHERK'S PAPER ENTITLED ZERO-SLOPE LIMIT OF THE DUAL RESONANCE MODEL. Nakanishi, Noboru (Kyoto Univ.). Progr. Theor. Phys. (Kyoto); 48: No. 1, 355-6(Jul 1972).

The following observation was recently made by Scherk: In the zero-slope limit, the dual resonance model reduces to the ϕ^3 theory. It is pointed out that Scherk's proof of this proposition is incorrect except for the case of 4-point tree graphs, but it is proved that his conclusion is true at least for all tree graphs. (T.B.S.)

Gravitation and General Relativity

Refer also to abstracts 53894 and 54162.

54389 (ITF-71-85-P) ABOUT THE INFINITESIMAL TRANSFORMATIONS CONSERVING THE TEST-BODY TRAJECTORIES IN GENERAL RELATIVITY. Aminova, A. V. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1971. 21p. (In Russian). Dep. NTIS (U. S. Sales Only).

Group methods in general relativity are developed. Groups of

projective motions, i.e., the groups of infinitesimal transformations, conserving the geodesic (the path of trial bodies) are discussed. A further step in defining the gravitational field in a unique manner by the test-body trajectories, this task is closely linked with important problems of modelling the field of gravitation and building fundamental mechanical and field laws of conservation in general relativity. The projective group properties of free and homogeneous fields of gravitation described by Einstein spaces are explored. The spaces V_4 that allow two independent constant vector fields among which the spaces of maximal projective mobility (variable curvature) are contained are also investigated. (auth)

54390 (ITF-71-130-P) ON THE MODELING OF GRAVITATIONAL FIELDS. Petrov, A. Z. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1971. 16p. (In Russian). Dep. NTIS (U. S. Sales Only).

The modeling of gravitational field is discussed within the framework of Einstein's theory. The modeling is defined as a mapping in which the geodesic lines (paths of test bodies) of the original transform into a family of the curves given by the equations of the test-body motion in a model. Different ways of modeling are indicated: Complete, selective, approximate-selective ones. The theory is applied for the solar gravitational field. (auth)

54391 (ITF-71-132-P) ON THE GEOMETRY OF RELATIVISTIC SPACE OF PARTICLE STATES. Schtrobel, Hans (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1971. 23p. (In Russian). Dep. NTIS (U. S. Sales Only).

The relativistic μ space (state space) of a free particle in a gravitational field is taken as a tangent bundle (fiber space) over the space–time V_4 and investigated as a special Riemannian space V_8 with the methods of Ricci calculus. The use of unholonomic coordinates is the most important remedy to make clear the symmetries of V_8, to define tensors in V_8 and relate them to tensors of V_4, and to prove theorems on vector fields and conservation, e.g., the relativistic Liouville theorem for point-sets on two 6-dimensional relativistic analogs of classical phase space. (1 figure). (auth)

54392 (ITF-72-3-P) RELATIONS BETWEEN THE COSMOLOGICAL AND QUANTUM CONSTANTS. Stanyukovich, K. P. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1972. 10p. (In Russian). Dep. NTIS (U. S. Sales Only).

The relations between cosmological and quantum constants are discussed. In particular, it is shown that, given three experimentally measured values G, c, and h, different in dimensions, as well as a scalar curvature R changing in time, it is possible to define all the remaining functions of fundamental values in terms of these four basic parameters. (auth)

54393 (ITF-72-5-P) ON THE SPATIAL LOCALIZABILITY OF ENERGY–MOMENTUM TENSOR OF GRAVITATIONAL FIELD. Kiriya, V. S.; Kereselidze, A. B.; Vepkhvadze, G. T.; Lezhava, O. I. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1972. 10p. (In Russian). Dep. NTIS (U. S. Sales Only).

Some properties of the energy-momentum tensor of gravitational field including the second derivatives of metric tensor are considered. Some of these properties are investigated by considering an example of Kötler's solution. (auth)

54394 (ITF-72-20-P) RIESSNER–NORDSTROEM PROBLEM IN PRESENCE OF SCALAR FIELD. Bronnikov, K. A. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1972. 13p. (In Russian). Dep. NTIS (U. S. Sales Only).

An exact static central-symmetric solution of the set of equations for the Einstein gravitational field, massless scalar field, and electromagnetic field is obtained and investigated. The scalar field Lagrangian density is chosen in the conformally invariant form $L_s = \phi^{*,\alpha}\phi_{,\alpha} - (R/6)\,\phi^*\phi$, where R is scalar curvature. This solution is compared with that of a similar problem with the usual scalar field Lagrangian density $L_s = \phi^{*,\alpha}\,\phi_{,\alpha}$. (auth)

54395 (ITF-72-21-P) SCALAR-TENSOR THEORY OF GRAVITATION. Zaitsev, N. A.; Kolesnikov, S. M.; Radynov, A. G. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1972. 37p. (In Russian). Dep. NTIS (U. S. Sales Only).

A new variant of the scalar-tensor theory of gravitation is proposed. The static field of a charged source is obtained. The first term of the expansion of this solution in inverse power series of the radius shows that the inclusion of an electric charge can both increase and decrease the mass of a neutral source. The solution obtained is compared with the observable effects of a geodesic motion of a test particle in the field of a central body. (auth)

54396 (ITF-72-41-P) COSMOLOGICAL MODELS OF A SCALAR-TENSOR THEORY OF GRAVITATION. Bronnikov, K. A.; Yakimov, V. E. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1972. 14p. (In Russian). Dep. NTIS (U. S. Sales Only).

Isotropic cosmological models in Zaitsev–Kolesnikov scalar-tensor theory of gravitation are considered. A number of qualitative conclusions is formulated, including conditions for a model to be singularity-free. For the case of massless scalar field exact solutions are obtained in the presence of dustlike matter and radiation. Among these solutions a class of models which may be used to describe the observable universe, is found. Some of these models are singularity-free. (auth)

54397 (ITF-72-46-P) TWO-SYMMETRIC AND TWO-RECURRENT FIELDS OF GRAVITATION. Kaigorodov, V. R. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1972. 21p. (In Russian). Dep. NTIS (U. S. Sales Only).

Two-symmetric and two-recurrent fields are investigated in detail by a single algebraic method which makes it possible to determine all classes of the relativistic spaces mentioned and to prove that the Lichnerowicz and Potter theorems proved for the spaces with a positively definite metric no longer hold in general relativity unless the space-times are conformally flat, and their scalar curvature is equal to zero. (auth)

54398 (ITF-72-52-P) TWO-BODY PROBLEM IN THE THEORY OF DIRECT GRAVITATIONAL INTERACTION. I. Zhdanov, V. I.; Piragas, K. A. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1972. 21p. (In Russian). Dep. NTIS (U. S. Sales Only).

The problem of two gravitating bodies is considered within the framework of Fokker formalism. The existence and uniqueness theorem for a solution of the equations of motion which arise from the vanishing of the first variation of Fokker action is proved under certain conditions. (auth)

54399 (ITF-72-58-P) ON A TWO-BODY PROBLEM IN THE THEORY OF DIRECT GRAVITATIONAL INTERACTION. Zhdanov, V. I.; Piragas, K. A. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1972. 24p. (In Russian). Dep. NTIS (U. S. Sales Only).

The two-body motion in a circular orbit in the theory of direct gravitational interaction. The problem of stability of such motion is the focus of the attention. It is shown that at small rates the formations of the binary star type are unstable. (auth)

54400 (ITF-72-59-P) RELATIVISTIC GRAVITATIONAL EFFECT ON INFLUENCE OF EARTH ROTATION ON MECHANICAL VIBRATIONS. Shirokov, M. F.; Ivashchenko, A. V. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1972. 12p. (In Russian). Dep. NTIS (U. S. Sales Only).

The general equations for small deviations ξ^i of the world line of a particle with one-dimensional elastic coupling from its equilibrium position in the earth laboratory on the equator are deduced. It is shown that the squares of frequency ω_θ and ω_ϕ vibrations of a particle in the planes of meridian and latitude differs from one another by the square of the earth rotation frequency u^3, with the correction of Einstein's theory of gravity by a magnitude $A(u^3)^2$ (m/R). (2 figures) (auth)

54401 (ITF-72-60-P) EFFECTS OF EINSTEIN'S THEORY OF GRAVITY AT THE TWO-PARTICLE VIBRATIONS IN SCHWARZCHILD'S FIELD. Ivashchenko, A. V. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1972. 6p. (In Russian). Dep. NTIS (U. S. Sales Only).

The transition from the Schwarzchild coordinate system in the central symmetrical gravitational field to that of the local pseudodecart connected with the observer moving in a geodetic or nongeodetic circle is determined. For a system consisting of 2 particles elastically coupled and moving in close geodesics in this field, the expression for the squares of vibration frequencies in various directions is obtained; it is equal to zero in the Newtonian case and different from zero in general relativity. This relation can be experimentally verified. (auth)

54402 LIE GROUPS AND THE THEORY OF GRAVITATION. Ketsaris, A. A. (Moscow Energy Inst.). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 12, 40-7(1970). (In Russian).

From length and time standards in the theory of gravitation, a generalized space with distortion and curvature determined by the fundamental group was constructed. Field variables coincide with coefficients ϵ_μ^i the infinitesimal group operator. It is shown that the structural equations of the group depend on the transformation properties of the object to which they are applied. The simplest equations which satisfy ϵ_μ^i are given. (tr-auth)

54403 TESTING GENERAL RELATIVITY: PROGRESS, PROBLEMS, AND PROSPECTS. Shapiro, I. I. (Massachusetts

Inst. of Tech., Cambridge). Gen. Relativity Gravitation; 3: No. 2, 135-48(Jun 1972).

Results from radar and radio gravity experiments are given for retardation of radar signals, deflection of radio waves, relativistic perihelion advance of Mercury, and time variation of the gravitational constant. The first three are expressed as fractions of the corresponding effects predicted by general relativity. In terms of the Eddington–Robertson parameters, the first two are approximately equal to $(1+\gamma)/2$ and the third to $(2+2\gamma-\beta)/3$. The third depends on the assumption that the solar gravitational quadrupole moment vanishes; its effects cannot be separated usefully from those of general relativity with the present data set. The uncertainties are as given by the individual experimenters; in some cases they represent formal standard errors, in others an allowance for possible systematic errors is included. (auth)

54404 POTENTIALS OF THE TYPE a_n/r^n, $n > 1$, IN COLLAPSING SYSTEMS OF GENERAL RELATIVITY THEORY. Berezin, V. A.; Markov, M. A. (Levedev Inst. of Physics, Moscow). Teor. Mat. Fiz.; 12: No. 2, 153-63(Aug 1972). (In Russian).

The nonlinear generalization of the Maxwell equations is constructed which leads to the static repulsive potentials of the type under consideration. The corresponding analog of the Nordström–Reissner metrics is constructed. In the framework of the classical (nonquantum) physics it is shown that the forces under consideration (a_n/r^{n+1}, $n > 1$) in general relativity theory do not lead to divergences of the self energy of their source. It is shown that in the case when the collapsing system goes beyond the gravitational radius ("the black hole"), the classical forces a_n/r^{n+1}, $n > 1$, as well as electrostatic and gravitational ones do not vanish in the external space. This result is contrary to the result by Hartle which was obtained for the pair neutrino forces ($\sim r^{-5}$). (auth)

54405 POTENTIAL IN THE CANONICAL FORMALISM OF GRAVITY. Kimura, Toshiei; Toiya, Takehiro (Hiroshima Univ.). Progr. Theor. Phys. (Kyoto); 48: No. 1, 316-28(Jul 1972).

An attempt is made to derive the gravitational potential from the canonical formalism viewpoint of the gravitational field coupled with matter. The two-body potential in an arbitrary coordinate frame (i.e., gauge) is obtained by solving constraint equations. It is shown, by making a transformation of the time coordinate, that the potential coincides with Hiida's obtained with the aid of the "diagrammatic" quantization. A simple equation to get the static potential to any order is presented. Explicit forms of the static potential are given up to the five-body potential. From the form of potential it is immediately seen that there exists a relation between two-body and many-body static potentials. (auth)

54406 GRAVITATIONAL WAVES OF THIRD AND HIGHER ORDER. Tokuoka, Tatsuo (Kyoto Univ.). Progr. Theor. Phys. (Kyoto): 48: No. 1, 333-4(Jul 1972).

The gravitational waves of third and higher order are discussed briefly for tensor and scalar-tensor fields according to analytic methods adopted by Tokuoka. The following conclusions are given: The gravitational waves of third and higher order for tensor and scalar-tensor fields have the identical propagation conditions with those of the second order, and they are classified into three types, transverse, longitudinal, and shear. The transverse wave is real and has speed c, while the longitudinal and shear waves are imaginary. (L.B.S.)

Scattering Theory

Refer also to abstracts 54345, 54711, 54737, and 55068.

54407 (BNL–16752) SCATTERING THEORY FOR ELLIPTIC DIFFERENTIAL OPERATORS IN UNBOUNDED DOMAINS. Goldstein, Charles I. (Wisconsin Univ., Madison. Mathematics Research Center). 10 Feb 1972. Contract DA-31-124-ARO-D-462. 60p. Dep. NTIS.

A new method is developed for meromorphically continuing the S-matrix and distorted waves associated with a general class of elliptic partial differential operators and for relating the poles to "resonant states". The method is applied to nonselfadjoint second-order perturbations of the Laplacian acting in wedge-like regions contained in R^N. The main analytic tools employed are the limiting absorption principle and the Schwarz reflection principle. (auth)

54408 (ITF–72–14–E) ON STABILITY OF THE SYSTEMS WITH SINGULAR POTENTIALS. Simenog, I. V. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1972. 6p. Dep. NTIS (U. S. Sales Only).

It is shown for the systems with singular attractive potentials, that the concept of independent particles in the sense of Hartree is exactly realized in the asymptotic limit $N \to \infty$. (auth)

54409 (ITF–72–37–P) ANALYTIC REGULARIZATION DEPENDING ON THE PARAMETER. Kovalenko, V. F. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1972. 20p. (In Russian). Dep. NTIS (U. S. Sales Only).

It is shown that logarithmic terms arising under the scale transformations of renormalized Feynman amplitudes are an additive finite regularization. Analytic regularization depending on the parameter which is an analog of subtraction point in the Bogolubov R-operation is defined. (auth)

54410 (ITF–72–38–P) BEHAVIOUR OF THE RENORMALIZED FEYNMAN AMPLITUDES UNDER SCALE TRANSFORMATIONS. Kovalenko, V. F. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1972. 22p. (In Russian). Dep. NTIS (U. S. Sales Only).

The behavior of analytically renormalized Feynman amplitudes under scale transformations in a scalar field theory with $\lambda L^4(x)$ interaction and $m^2 \neq 0$ is studied. It is shown that under the scale transformations of renormalized Feynman amplitudes, the logarithmic terms arise as a result of regularization. The results obtained make it possible to define large-momentum behavior of an arbitrary renormalized Feynman amplitude and to investigate the violation of homogeneity of Feynman amplitudes by regularization at $m^2 \to 0$. (auth)

54411 (ITF–72–39–P) VIOLATION OF THE HOMOGENEITY OF THE FEYNMAN AMPLITUDES OF SELF-ENERGY GRAPHS UNDER REGULARIZATION. Kovalenko, V. F. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1972. 11p. (In Russian). Dep. NTIS (U. S. Sales Only).

It is shown that analytic regularization violates the homogeneity of Feynman amplitudes of self-energy graphs in a zero-mass scalar field theory with $\lambda\phi^4(x)$ interaction. Analysis of the logarithmic terms breaking homogeneity leads one to conclude that with $m^2 = 0$, the renormalized Feynman amplitudes of self-energy graphs are homogeneous functions under combined scale transformations of the parameter of analytic regularization and momenta. (auth)

54412 (ITF–72–63–E) DAMA AND REGGE ASYMPTOTIC BEHAVIOUR. Bugrii, A. I.; Enkovskii, L. L.; Kobylinskii, N. A.; Shelest, V. P. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1972. 16p. Dep. NTIS (U. S. Sales Only).

The high-energy behavior of a dual amplitude with Mandelstam analyticity (DAMA) is investigated. A detailed analysis of this dependence of the asymptotic behavior of DAMA on the position of the boundary of the spectral function and on the asymptotic form of the Regge trajectory is given. It is proved that the amplitude does have Regge asymptotic behavior for arbitrary momentum transfers if the trajectories increase more slowly than S. (3 figures) (auth)

54413 (JINR–P2–6586) PROOF OF UNITARITY OF THE S-MATRIX IN NON-LOCAL QUANTUM FIELD THEORY. Alebastrov, V. A.; Efimov, G. V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1972. 17p. (In Russian). Dep. NTIS (U. S. Sales Only).

In nonlocal quantum field theory the unitarity of the S-matrix is proved in each order of perturbation theory for polynomial Lagrangians. (auth)

54414 UNITARITY AND THE INHOMOGENEOUS EQUATIONS METHOD FOR IDENTICAL PARTICLE SCATTERING. Levin, F. S. (Brown Univ., Providence). Ann. Phys. (N. Y.); 72: No. 2, 497-511(Aug 1972).

A K-matrix solution to the coupled, inhomogeneous equations describing the scattering of a particle by a system of identical particles is developed. It is shown that K is a sum of two terms, one arising from the homogeneous solution and one from the particular integral. The former is a direct contribution, i.e., with no exchange, while the latter is a pure exchange contribution. Thus, as in the previously studied case of the T matrix arising from this system of equations, the direct and exchange portions of K are additive, and can be computed separately. A unitary S matrix is obtained from K in the usual way: $S = (1+iK)(1-iK)^{-1}$. The problem of how to calculate K when an apparent two-channel problem is actually a two-particle problem with the channels referring to the identical particle labels is also solved. (auth)

54415 DIFFRACTION SCATTERING OF CHARGED PARTICLES. Frahn, W. E. (Univ. of Capetown, S. Afr.). Ann. Phys. (N. Y.); 72: No. 2, 524-47(Aug 1972).

It is shown that, contrary to popular belief, diffraction scattering in nuclear and particle physics is not always of Fraunhofer type. By establishing a simple physical connection between scattering in a Coulomb field and Fresnel diffraction, it is shown that diffractive collisions of heavy charged particles are predominantly

of Fresnel type. Quantitative criteria for Fraunhofer and Fresnel scattering are derived which lead to a classification of all scattering processes by means of a "diffraction diagram." This enables specific prediction to be made about the gross structure of angular distributions for any experimental conditions. (10 figures) (auth)

54416 S-MATRIX APPROACH TO GLAUBER THEORY. Osborn, T. A. (Brooklyn Coll., New York). Nucl. Phys.; B46: No. 2, 538-46(1972).

An S-matrix approach to Glauber theory based on an eikonal-Hamiltonian formalism is presented. The variant of Glauber's multiple diffraction theory obtained here is rigorously unitary. The construction of the approximate composite scattering amplitudes requires only two-body phase shift data. (auth)

54417 FOUR-FERMION SCATTERING AMPLITUDE FREE FROM KINEMATICAL SINGULARITIES. Gogolitsin, Yu. L.; Prokhorov, L. V. (Leningrad State Univ.). Lett. Nuovo Cim.; 4: No. 14, 715-18(5 Aug 1972).

An attempt is made to find the general four-fermion scattering amplitude using CPT and relativistic invariance only. Identities are found which allow the possibility for choosing the set of invariant amplitudes free from kinematic singularities. (L.B.S.)

54418 UNITARITY CONSTRAINTS ON HELICITY AMPLITUDES. Hodgkinson, D. P. (Cavendish Lab., Cambridge, Eng.). Lett. Nuovo Cim.; 4: No. 14, 731-5(5 Aug 1972).

It is shown that bounds analogous to those derived by Singh and Roy (Phys. Rev. D, 2: 2638(1970)) exist for a suitably chosen amplitude, which is the sum of all amplitudes with no helicity-flip. New unitary restrictions on helicity-flip amplitudes are also discussed. (L.B.S.)

54419 HELICITY-CONSERVING AND HELICITY-NONCONSERVING POMERON-EXCHANGE AMPLITUDES IN THE DUAL ABSORPTIVE MODEL. Avni, Y. (Stanford Univ., Calif.). Lett. Nuovo Cim.; 4: No. 14, 725-30(5 Aug 1972).

It is shown that the present dual absorptive model has no predictive power with respect to the presence of zeros in t in pomeron-exchange diffractive amplitudes. Thus it is concluded that the correct description of the t-dependence of the diffractive amplitudes in meson-baryon reactions should not be considered as a success of the model, and the possible existence of a zero in the diffractive amplitudes of $pp \rightarrow pp$ should not be considered as a failure of the model. It is suggested that the strong predictive power of the dual absorptive model for nondiffractive amplitudes may serve as a very useful tool in deciding whether the possible helicity nonconservation in $\gamma p \rightarrow \rho^0 p$ is a property of diffractive amplitudes. (L.B.S.)

54420 NEW DERIVATION OF THE OFF-SHELL DUAL-RESONANCE AMPLITUDES. Tataru-Mihai, P. I. (Univ., Cluj). Lett. Nuovo Cim.; 4: No. 14, 711-14(5 Aug 1972).

A new attempt to derive an off-shell dual-resonance amplitude is presented. As a basic property the invariance of the integrand of the dual-resonance amplitude under Moebius transformations is considered. (L.B.S.)

54421 APPLICATION OF THE NEWTON–KANTOROVICH METHOD TO THE CHEW–LOW N/D EQUATIONS. I. Taira, Konno; Nelipa, N. F. (Moscow State Univ.). Teor. Mat. Fiz.; 12: No. 2, 214-22(Aug 1972). (In Russian).

By means of the Newton–Kantorovich method the sequence of iterations of the Chew–Low equations put in the N/D form is obtained taking into account the Castilljeho–Dalitz–Dyson poles. The convergence conditions of this sequence of iterations are found. The estimation of the coupling constant is performed. (auth)

54422 GENERALIZATION OF SEMILOCAL DUALITY. Ball, J. S.; Pinsky, Stephen (Univ. of Utah, Salt Lake City). Phys. Rev., D; 6: No. 5, 1456-7(1 Sep 1972).

Semilocal duality is applied to the process $a + b + c \rightarrow a + b + c$, in the double-Regge region. Using the Mueller formalism, this leads to a formula for elastic and quasielastic two-body scattering at large momentum transfers previously proposed by the authors. (auth)

54423 POSSIBLE BEHAVIOR OF REGGE TRAJECTORIES IN VENEZIANO-LIKE REPRESENTATIONS. Kobayashi, Masanori (Kyoto Univ.). Progr. Theor. Phys. (Kyoto); 48: No. 1, 267-71(Jul 1972).

Canonical product representations for scattering amplitudes which possess meromorphy in s and t as well as Regge behaviour are investigated in terms of entire functions of order ρ. The representation found turns out to be of order either $\rho = 1$ or $\rho = 0$. The case of $\rho = 1$ corresponds to the Veneziano representation and the case of $\rho = 0$ to the Coon representation which has logarithmic trajectories and polynomial residues of order n in s(t) at the n-th pole in t(s). (auth)

PHYSICS (LOW-TEMPERATURE)

Superfluidity

54424 HIGH-FREQUENCY HYDRODYNAMICS NEAR THE λ POINT. Khalatnikov, I. M.; Pokrovskii, V. L.; Semiz, D. M. (Landau Inst. for Theoretical Physics, Moscow). J. Low Temp. Phys.; 6: No. 3-4, 305-21(Feb 1972).

Dynamic phenomena are treated in a weakly interacting Bose gas model. It is considered that particles with momenta higher than the coupling constant g are free and distributed on energies according to Bose–Einstein statistics. In the critical regions all momenta are divided into two regions: an ideal-gas region $p \ll g$, and a small fluctuation region $p \lesssim g$. From the microscopic theory, the hydrodynamic wave equation is derived analogous to the combination of the Navier–Stokes and mass conservation law equations. The mechanocaloric effect is also considered. In the evaluation of the fluctuations–free particles coupling, the usual microscopic technique in the many-body problem was used. (M.H.R.)

54425 ROTON-LIMITED MOBILITY OF IONS IN SUPERFLUID ^{4}He. Barrera, Ruben, Baym, Gordon (Univ. of Illinois, Urbana). Phys. Rev., A; 6: No. 4, 1558-66(Oct 1972).

The roton-limited mobility of ions in superfluid ^{4}He are calculated for temperatures below ~1.7°K. Taking, as a first approximation, a constant ion-roton transition-matrix element, which is treated as an adjustable parameter, good agreement is found with experiment for both positive and negative ions. This model calculation indicates that the most mobile of the recently discovered exotic negative carriers is a very light ion. (auth)

54426 STUDY OF THE SPECIFIC HEAT OF A ^{3}He–^{4}He MIXTURE NEAR ITS GAS–LIQUID CRITICAL POINT. Brown, G. Raymond; Meyer, Horst (Duke Univ., Durham, N. C.). Phys. Rev., A; 6: No. 4, 1578-87(Oct 1972).

Measurements are presented of the specific heat C_{vx} of a mixture of ^{3}He and ^{4}He with a nominal concentration of ^{3}He, $X_3 = 0.80$. Data were taken with a flat calorimeter cell in the vicinity of the gas–liquid critical point of the mixture, which is characterized (at a given X_3) by its density ρ_c and temperature T_c. The data consist of nine isochores within the approximate density range $0.52 < \rho/\rho_c < 1.20$ and in the temperature range $-0.1 \leq t \leq 0.1$, where $t = (T - T_c)/T_c$. Data were taken to within 0.4 mK of the transition temperature on all but one of the isochores. It was found that the behavior of the specific heat in the mixture for a given reduced density ρ/ρ_c is in general very similar to that seen in pure ^{3}He. In particular, the behavior of C_{vx} along the critical isochore is the same as that for pure ^{3}He in the range $10^{-4} \leq t \leq 10^{-2}$. There the apparent weak divergence is characterized by an exponent $\alpha \approx 0.1$. From thermodynamic considerations of the upper bound of C_{vx} along a line of singularities in mixtures, the apparent weak divergence observed does not, however, represent the asymptotic behavior. This question is discussed in the light of the paper by Griffiths and Wheeler and of new calculations by Leung and Griffiths for a binary fluid. The thermal-equilibrium times in the two-phase region were found to be much longer than the pure ^{3}He fluid, and these are briefly discussed. The thermal diffusivity in this region is found to have a maximum at a density approximately 20% lower than ρ_c, in rough correspondence to the density of the temperature extremum of the two-phase-region boundary. (auth)

54427 APPLICATION OF THE EQUATION-OF-MOTION METHOD TO THE SPECTRUM OF SUPERFLUID HELIUM. II. Enz, Charles P. (IBM Zurich Research Lab.). Phys. Rev., A; 6: No. 4, 1605-13(Oct 1972).

On the basis of the formalism developed in a previous paper, several features of the two-branch excitation spectrum observed by Cowley and Woods are discussed. In the long-wavelength limit a T^4 dependence of the sound velocity is derived, which is in agreement with a T^3 law for the specific heat. Furthermore, a simple derivation of the Pitavskii singularity at the end point $q_c \cong 3.55$ Å^{-1} of the phonon–roton spectrum is presented, and it is argued that, above q_c, the excitations are essentially decoupled from the condensate. Finally, the author gives convincing arguments that the diffuse second branch of Cowley and Woods should converge, for $q \to 0$, near twice the roton gap where, however, it should disappear in neutron scattering but show up in Raman scattering, in accordance with experiments by Greytak et al. (auth)

54428 APPLICATION OF THE EQUATION-OF-MOTION METHOD TO THE SPECTRUM OF SUPERFLUID HELIUM. I. Enz, Charles P. (IBM Zurich Research Lab.). Phys. Rev., A; 6: No. 4, 1596-1605(Oct 1972).

The two three-body correlation terms occurring in the equation of motion for the density response function are expressed in terms of three-point vertex functions. By neglecting retardation effects in the latter, this leads to frequency-dependent effective kinetic and potential energies $K_{eff}(\vec{q},\omega)$ and $V_{eff}(\vec{q},\omega)$. K_{eff} is expressed by the one-particle correlation functions and V_{eff} by the density correlation function. K_{eff} and V_{eff} determine the density response function $\chi(\vec{q},\omega)$, the poles of which define the phonon–roton spectrum ω_q. In addition, an eigenvalue equation is derived which is shown to have two distinct eigenvalues. While the first is again ω_q, the second is identified with the diffuse second branch recently found by Cowley and Woods. It is shown that in the limit $q \to \infty$ the two eigenvalues both merge into the free-particle spectrum. The limit $q \to 0$ of the two eigenvalues as well as the endpoint singularity of the phonon–roton branch are discussed in a second paper. (auth)

54429 THEORY OF THE ROTON LIFETIME IN SUPERFLUID HELIUM. Solana, J. (Univ. of Virginia, Charlottesville); Celli, V.; Ruvalds, J.; Tuettoe, I.; Zawadowski, A. Phys. Rev., A; 6: No. 4, 1665-76(Oct 1972).

The theory of the roton lifetime is extended to include two-roton resonances in the final-state interaction. When resonances are taken into account, the final density of states ρ_2 exhibits a complicated energy dependence and bears little resemblance to the noninteracting roton density $\rho_2^{(0)}$ used in the Landau–Khalatnikov theory. Using a point-interaction model for the roton coupling and including only direct roton–roton scattering, a single-roton linewidth is obtained that is consistent with the upper bound given by other authors; then a linewidth is obtained for the two-roton resonance that is smaller than the experimental value. In contrast to previous work, roton hydridization is included in the lifetime theory. The effect of hybridization is twofold: (a) The final density of states ρ_2 is markedly altered, and (b) the hybridization opens new scattering channels involving a single quasiparticle in the final state. Although the net effect of mechanism (a) on the roton lifetime seems to be small, the additional scattering (b) gives a non-negligible contribution. Furthermore, the importance of self-consistency and roton scattering in nonzero angular momentum channels is discussed. The theory predicts an unusual pressure dependence for the roton linewidth which may be checked experimentally. It is concluded that further experiments, such as light and neutron scattering, are needed to resolve the strength of the various contributions to the linewidth and thereby provide a truly quantitative analysis of the roton lifetime. (auth)

54430 SCINTILLATION OF LIQUIDS ^{3}He, ^{4}He, AND ^{3}He–^{4}He SOLUTIONS. Roberts, Huey Allen. Charlottesville, Va.; Univ. of Virginia (1972). 104p. University Microfilms Order No. 72-22,638.

Thesis.

An investigation was made of the alpha-particle-induced scintillation intensity of liquids He II and ^{3}He–^{4}He solutions between 2.15°K at the vapor pressure and of pure ^{3}He between 4.2°K and 0.3°K at pressures ranging from the vapor pressure to a pressure of 8 atmospheres. It has been found that about 30% of the total luminescence from He II and ^{3}He–^{4}He solutions above 1.2°K derives from radiative destruction of metastable states. The pulse-height intensity decreases 16% between 1.8°K and 0.7°K. Between 1.8°K and 1.2°K the drop in pulse height is 9% whereas the total intensity is constant in this region, thus, indicating delayed photon emissions. A model based on a temperature-dependent radiative destruction rate for metastable states is proposed to account for the temperature variations in pulse height of He II and ^{3}He–^{4}He solutions. The pulse height data for ^{3}He–^{4}He solutions suggests that ^{3}He atoms condense onto metastable structures in the vicinity of the alpha track. Variations in ^{3}He scintillations with temperature and pressure are discussed in terms of a pressure- and temperature-dependent radiative recombination of ions. (Diss. Abstr. Int., B)

54431 NEW FEATURES OF He II FILM FLOW TRANSFER. Esel'son, B. N.; Ivanov, V. G.; Shcherbachenko, R. I. (Physical-Technical Inst. of Low Temperature, Kharkov). JETP Lett. (USSR) (Engl. Transl.); 15: No. 10, 435-7(20 May 1972).

Translated from Zh. Eksp. Teor. Fiz.; Pis'ma Red.; 15: No. 10, 616-18(20 May 1972).

Unusual He II flow phenomena were observed for Plexiglas ampoules in glass vessels. For outflow (He level higher in the ampoule than in vessel), the transfer rate does not stop at zero level difference ($\Delta H = 0$) but continues until the ampoule is completely emptied. Preparation of the Plexiglas affected this phenomenon. For inflow into the ampoule, no transfer occurred at

all for large H. Gradual lowering of the ampoule led to onset of inflow at several mm, but the inflow did not continue until $\Delta H = 0$, but stopped suddenly at values of ΔH far from zero. These phenomena were not observed for ordinary glass ampoules. Several possible causes are suggested, including electrification of the Plexiglas. (D.L.C.)

54432 THERMODYNAMIC STABILITY OF A NON-IDEAL BOSE–EINSTEIN GAS. Semenchenko, V. K.; Soldatov, E. D. (Moscow State Univ.). Russ. J. Phys. Chem. (Engl. Transl.); 46: No. 1, 131-2(Jan 1972).

Translated from Zh. Fiz. Khim.; 46: No. 1, 221-2(Jan 1972).

The calculations and analysis of the thermodynamic stability of a nonideal Bose–Einstein gas (taking into account the repulsion forces between bosons on the basis of the first approximation of the perturbation theory) shows that, in terms of this approximation, the gas may reach a state with limiting stability. (auth)

54433 OSMOTIC PRESSURE WAVES IN SOLUTIONS OF ^{3}He IN SUPERFLUID ^{4}He. Ghozlan, A. (Univ. Paris, Orsay, France). J. Phys. (Paris); 33: No. 4, 415-22(Apr 1972). (In French).

A simple thermodynamic relation between the second sound velocity in ^{3}He–^{4}He mixtures and the osmotic and fountain pressures was established. The second sound in helium mixtures is interpreted as a wave corresponding to the osmotic pressure of the normal fluid with respect to the superfluid component. This relation and the expression given by Varoquaux for the osmotic pressure were used to determine the second sound velocity at any temperature. The values obtained are in agreement with the experimental results. (France)

54434 EVALUATION OF THE ENERGY FLUX BETWEEN TWO SUPERFLUID He BATHS SEPARATED BY A THIN METALLIC FOIL. Seiden, Joseph (Univ. Paris, Orsay, France). Compt. Rend., Ser. B; 274: No. 22, 1191-4(29 May 1972). (In French).

The energy of the flux crossing a thin metallic foil separating two superfluid He baths having temperatures of T and T + ΔT was calculated previously by applying a phonon transport equation to the foil. The existence of phonons and electrons in the foil at different local temperatures (T_p and T_e) was neglected. A calculation is presented in which the existence of phonons and electrons is treated in a perfectly coherent manner, and a better agreement between theory and experiment subsequently obtained. (France)

Superconductivity

Refer also to abstracts 53759 and 55047.

54435 (ITF-72-56-E) SOME EXACTLY SOLVABLE MODEL PROBLEM WITH POSITIVE INTERACTION. Bogolyubov, N. N. Jr.; Shumovskii, A. S. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1972. 11p. Dep. NTIS (U. S. Sales Only).

The mathematically exact method is presented for constructing an asymptotic expression for free energy of general quasi-spin model with pair positive interaction. (auth)

54436 (NP-19425) INFLUENCE OF DIMENSIONALITY ON BOSE CONDENSATION AND MACROSCOPIC COHERENCE IN SUPERCONDUCTORS. Note No. 365. Lucano, G.; Pace, S.; Romani, G. L. (Rome Univ. (Italy). Istituto di Fisica). 23 Mar 1972. 6p. Dep. NTIS (U. S. Sales Only).

A numerical evaluation of the Bose condensation temperature for superconductors of restricted dimensionality is given and dimensionality's influence on the appearance of a specific macroscopic coherence effect, i.e., flux quantization, is discussed. (M.H.R.)

54437 ULTRASONIC EVIDENCE AGAINST MULTIPLE ENERGY GAPS IN SUPERCONDUCTING NIOBIUM. Almond, D. P.; Lea, M. J.; Dobbs, E. R. (Univ. of Lancaster, Eng.). Phys. Rev. Lett.; 29: No. 12, 764-7(18 Sep 1972).

The attenuation of longitudinal ultrasound along the [100] direction in Nb, resistivity ratio $R_{300}/R_0 = 5200$, was measured with precision at low temperatures. The total attenuation in the normal state can be accurately deduced by a BCS calculation, with a single gap $2\Delta(0) = (3.52 \pm 0.02)kT_c$, from the measured superconducting attenuation. No experimental evidence was found for the existence of either a smaller or a larger gap. (auth)

54438 STUDY OF SUPERCONDUCTIVITY IN FAST FROZEN (SPLAT-COOLED) INDIUM–GALLIUM ALLOYS (INCLUDING A CRITICAL ANALYSIS OF THE AC SUSCEPTIBILITY FOR STUDYING NORMAL PROPERTIES OF METALS). Carroll, Paul Joseph. Washington, D. C.; Georgetown Univ. (1972). 225p. University Microfilms Order No. 72-22,769.

Thesis.

The superconducting properties of seven fast frozen (77 K) In–Ga samples of varying indium concentration (0 to 10% by weight) were studied using ac susceptibility, dc magnetization and specific heat capacity methods. Several models of superconductivity for the In–Ga system were analyzed using the superconductivity data. The resistive component behavior of In–Ga and pure single-crystal gallium samples in ac magnetic fields was also studied. The temperature, T_p, at which the peak occurs was calculated for resistively isotropic and anisotropic materials. The variation of T_p with frequency was measured in single-crystal gallium samples. Measurements of $T_p(\omega)$ for a single-crystal gallium sample show that $\ln \rho_{peak} \sim \ln \omega_{peak}$ for both measured $T_p(\omega)$ and $T_p(\omega)$ calculated using the anisotropic model. This proportionality relation between $\ln \rho(T)$ of gallium reported in the literature and $\ln \omega_{peak}$, both measured and calculated, suggests that the temperature variation of the resistivity of a material may be calculated within constant from measurements of T_p as a function of frequency. (TSS) (Diss. Abstr. Int., B)

54439 LOW-FREQUENCY ACOUSTIC INTERACTIONS IN SUPERCONDUCTORS. Goodrich, Gary Wayne. Stillwater, Okla.; Oklahoma State Univ. (1971). 123p. University Microfilms Order No. 72-21,872.

Thesis.

This investigation involved the use of acoustical measurement techniques to observe the superconducting-to-normal-state transition in Type-I (Ta,Sn) and Type-II (Nb,V) superconductors. Parameters such as the modulus of elasticity, the attenuation coefficients, and magnetization were used to study the superconducting transition. The low-frequency acoustic interaction with a magnetic field for metals in the normal state was developed theoretically and found to be in very good agreement with the experimental results for the longitudinal mode. The torsional mode lacks a theoretical explanation, since the proposed theories yield results two orders of magnitude too small compared to the experimental results for the modulus and one order of magnitude too small for the acoustic loss factor. The changes in torsional modulus do follow a quadratic dependence on magnetic field like the longitudinal mode. An unusual effect was found in the normal-state anisotropic elasticity of both the longitudinal and torsional modes. The observation of lobes along the primary slip planes for the (111) oriented crystals seems to indicate that dislocations are the primary mechanism responsible for the anisotropy. In the superconducting state data, the dislocation effect was observed via a magnetic fluctuation in the acoustic attenuation above H_{c2}. The acoustic parameters were shown to be indicative of the characteristic features of superconductors by their comparison with magnetization data which was taken simultaneously with the elastic data. The total change in longitudinal modulus across the transition was related to the electronic-mean-free-path-dependent coherence length. The changes in modulus across the superconducting mixed state were shown to be dependent on the normal volume fraction of material for both types of modes, while the attenuation was not dependent on this. This pointed out the difference between the harmonic and anharmonic components of elasticity, and it indicated the value of these simultaneous measurements. (TSS) (Diss. Abstr. Int., B)

54440 ANISOTROPY OF SURFACE SUPERCONDUCTIVITY OF LEAD SINGLE CRYSTALS. Krasnopolin, I. Ya.; Rup, Raj; Khaikin, M. S. (Inst. of Physics Problems, Moscow). JETP Lett. (USSR) (Engl. Transl.); 15: No. 9, 365-8(5 May 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 15: No. 9, 516-20(5 May 1972).

Measurements are reported of the surface resistance of lead single crystals in which superconductivity has been destroyed by a magnetic field. The anisotropy of the field H_{c3} was investigated in detail in the (011) plane, and the results are shown. The temperature dependence is shown of $H_{c3}(t)/\sqrt{2}\,H_c(t) = C(t)\,\kappa(t)$, normalized to its values at t = 1, for three rational directions in the (011) plane. (M.H.R.)

54441 ENTROPY OF VORTICES IN SUPERCONDUCTORS. de Lange, Owen Leon Potsdam, N. Y.; Clarkson Coll. of Tech. (1972). 149p. University Microfilms Order No. 72-21,593.

Thesis.

The research reported here is concerned with the transport (S_t) and incremental (S_i) entropy of vortices in superconductors, and with a comparison of the thermal gradient and Lorentz forces on a vortex in a type-II superconductor. A brief introduction and review are presented. The experimental method used to measure the transport entropy and the results of the experiments on Nb_{80}–^{20}Mo are given. The results indicate that, at low reduced temperatures and low fields, the transport entropy exceeds the incremental entropy of vortices. A simple model for the low-field transport and

incremental entropy, which seems capable of explaining this observation, is given. The theory for S_d and S_l is compared with all available experimental results, and the following conclusions are reached: (i) in a relatively pure type-I and a pure-II superconductor the thermal gradient contribution to S_d is absent, and the core contribution is in good agreement with experiment; (ii) in the dirty type-II superconductors the thermal gradient contribution is present, and agreement with experiment is satisfactory at low reduced temperature, but not near T_c, where the S_d calculated for an isolated vortex is too large. An explanation is suggested in a chapter where the effects of vortex interaction are discussed. The field dependence of S_l at low fields is treated using the London model, and the results are compared with experiment. The model is further checked by calculating the relative change in energy gap with field, at low fields, from the experimental field dependence of S_d and S_l. The results from S_d and S_l agree to within experimental error. It is pointed out that the slope of the incremental entropy at the upper critical field, $(\partial S_l/\partial B)B_{c2}$ provides a sensitive test of the microscopic theory: the third-order term, $\phi_m(T) = -(1/\phi)(\partial^3 \Delta G_{mn}/\partial B^3)B_{c2}$, in the Gibbs free energy is related to $(\partial S_l/\partial B)B_{c2}$ and compared with experiment. Measurements of the Lorentz force and the thermal gradient force on a vortex in a bulk type-II superconductor (^{80}Nb–^{20}Mo) are presented. The two forces are found to be quite different in magnitude. The field and temperature dependence of the forces indicates that interaction with the surface is the dominant mechanism of vortex pinning is this sample. Consideration of this mechanism suggests an explanation for the inequality of the two forces. At intermediate reduced temperatures the penetration depth and transport entropy vary only slightly in the sample when a fairly small temperature gradient is applied. Near T_c the Lorentz force exceeds the thermal gradient force by an order of magnitude, and a qualitative explanation is proposed, based on the change in penetration depth and transport entropy at the cold surface (where the flux driven by a thermal gradient is exiting) relative to their values at the center of the sample. (Diss. Abstr. Int., B)

54442 ROLE OF PARAMAGNETIC IMPURITIES IN THE BARRIER REGION FOR SUPERCONDUCTING TUNNELLING. Gupta, H. M.; Upadhyaya, U. N. (Univ., Udaipur, India). J. Phys., C (London); 5: No. 14, 1806-16(24 Jul 1972).

A microscopic theory for the tunnelling current through a superconductor/insulator/superconductor junction containing a pair of paramagnetic impurities is developed. A general interaction between the impurity spins is considered and the tunnelling current is calculated by considering both the elastic and inelastic scattering of conduction electrons with the impurity pair. It is found that the single particle tunnelling current exhibits discontinuities as a function of the bias voltage. The positions of discontinuities occur at voltages which depend on the energy gap and the strength of the impurity–impurity interaction. (auth)

54443 EXCITATIONS IN THE QUANTUM CONDENSATED FERMION GAS. Lueders, Gerhart (Univ., Goettingen, Ger.). Z. Phys.; 253: No. 5, 391-403(1972).

The excitations (both collective and quasi pair states) connected with quantum condensation of a fermion gas are examined. These gapless excitations do not only turn up for finite-range interaction but also for Coulomb interaction, i.e., as electronic excitations in a superconductor. (auth)

54444 SUPERCONDUCTIVITY IN THE Mg–Cd SYSTEM: EXTRAPOLATED T_c FOR PURE MAGNESIUM. Mota, A. C. (Univ. of California, San Diego, La Jolla); Brewster, P.; Wang, R. Phys. Lett.; 41A: No. 2, 99-101(11 Sep 1972).

Measurements of superconducting transition temperatures for the system Mg–Cd are reported. An extrapolation from the data on Mg-rich alloys gives a value of $T_c = 0.5$ m°K for pure magnesium. (auth)

54445 INFLUENCE OF FERMI-SURFACE TOPOLOGY CHANGE UNDER PRESSURE ON TWO-BAND SUPERCONDUCTORS PROPERTIES. Pallstrant, M. E.; Kolpagiu, M. K. (Inst. of Applied Physics, Kishinev, USSR). Phys. Lett.; 41A: No. 2, 123-4(11 Sep 1972).

An investigation is made of the influence of Fermi-surface topology change under pressure on the superconducting transition temperature T_c and on energy gaps at zero temperature $\gamma_n(0)$ of a two-band superconductor. Two extrema in the pressure derivate of T_c and $\gamma_n(0)$ are predicted. (auth)

54446 GAP PARAMETER OUTSIDE THE CORE OF AN ISOLATED FLUX LINE FOR $T \geq 0.7\ T_c$. Brandt, E. H. (Institut fuer Physik, Stuttgart). Phys. Lett.; 41A: No. 2, 127-8(11 Sep 1972).

The gap parameter of an isolated flux line is shown to increase monotonically for large distances from the vortex core and to never exceed the BCS value $\Delta_0(T)$. (auth)

54447 DEPENDENCE OF VARIATION OF THE DISLOCATION ELECTRON SLOWING DOWN FORCE IN A SUPERCONDUCTING TRANSITION ON STRESS, TEMPERATURE, AND VELOCITY. Fomenko, V. S. (Physical-Technical Inst. of Low Temperatures, Kharkov). Zh. Eksp. Teor. Fiz.; 62: No. 6, 2190-8(Jun 1972). (In Russian).

The effect of stress, temperature, and deforming rate on variation of the deforming stress $\Delta\sigma$ arising on transition of a sample from the superconducting to normal state under conditions of uniform deforming rate is studied. The samples studied were Pb (99.9995% and 99.97%), In (99.999%) and the alloy Pb–13 at. % In. Purity of the metal was found to affect the dependence of $\Delta\sigma$ on stress and temperature. The dependence $\Delta\sigma(\sigma)$ was different for the alloy and pure metals. A dependence of $\Delta\sigma$ on the deforming rate was observed at 1.65°K. It is shown that a comparison of the experimental results with present day theoretical concepts regarding the change of the interaction mechanism between conductivity electrons and dislocations during superconducting transitions does not permit one to give preference to any of them. (auth)

54448 STRUCTURE OF THE MIXED STATE NEAR THE BOUNDARY OF A SEMI-INFINITE SUPERCONDUCTOR OF THE SECOND KIND. Ternovskii, F. F.; Shekhata, L. N. (Moscow State Univ.). Zh. Eksp. Teor. Fiz.; 62: No. 6, 2297-2310(Jun 1972). (In Russian).

The equilibrium equations for vortex lines are solved for a number of particular cases by taking into account interaction of the lines with the boundary of an ideal Type-II superconductor. It is shown that, for a certain position with respect to the boundary, the vortex-line lattice is almost not deformed. The maximum and minimum values of the external field, for which a mixed state with a prescribed induction value can still exist, are determined. (auth)

54449 SUPERCONDUCTIVITY IN SEMICONDUCTORS. Shneerson, V. L. (Inst. of Theoretical Physics, Moscow). Zh. Eksp. Teor. Fiz.; 62: No. 6, 2311-17(Jun 1972). (In Russian).

A model of a polar degenerate semiconductor with a low-lying branch of transverse optical oscillations is considered. For impurity concentrations sufficient for obtaining a high-density carrier gas, the semiconductor at sufficiently low temperatures goes over to the superconducting state. The interaction between electrons and phonons of the low-lying branch, which is specifically strong with respect to the parameter ϵ_0, is responsible for the superconductivity. (auth)

54450 SPECIFIC HEAT OF GRANULAR ALUMINUM FILMS. Greene, R. L. (Stanford Univ., Calif.); King, C. N.; Zubeck, R. B.; Hauser, J. J. Phys. Rev., B; 6: No. 9, 3297-3305(1 Nov 1972).

The specific heat of granular Al–Al_2O_3 films with $T_c \cong 2$°K was measured between 1.3 and 8°K. The results show that the enhancement of T_c is a bulk effect. Within experimental accuracy the electron density of states at the Fermi surface is the same as that of pure Al. The lattice heat capacity is increased in the granular films such that the measured Θ_D is 28% less than that of pure Al. This result indicates that the phonon density of states is greatly enhanced at low frequencies and seems to confirm the tunneling data of Klein and Leger. The experimental methods used to measure the small (~0.5 erg/°K) heat capacity of the films are discussed. The thermal conductivity of Au–7 at. % Cu wire and the heat capacity of silicon (~50 mg) were also measured to test the capability and accuracy of the experimental techniques. (auth)

54451 THERMAL CONDUCTIVITY IN DIRTY TRANSITION-METAL SUPERCONDUCTORS NEAR THE UPPER CRITICAL FIELD. Chow, W. S. (Univ. of Cincinnati). Phys. Rev., B; 6: No. 9, 3315-21(1 Nov 1972).

The two-band model is used to explain the thermal conductivity in dirty type-II transition-metal superconductors, such as niobium and vanadium, immediately below the upper critical field $H_{c2}(T)$. It is shown that because of the existence of interband impurity scattering, characterized by the interband-impurity-scattering relaxation time τ_{ds}, and with τ_{ds}^{-1} acting as a pair-breaking parameter, the d-band thermal conductivity immediately below the upper critical field $K_d^{(s)}$ is given by the following relation: $K_d^{(s)} = K_d^{(n)} - (1/2e)\{(H_{c2} - H)/[2\kappa_2^2(t) - 1]\beta_A\}\rho\, L(t)$, where $K_d^{(n)}$ is the thermal conductivity of the d band in the normal state and $\rho = \epsilon_{d0}/4\pi T = 2eD_d H_{c2}/4\pi T$. It is noted that L(t) as a function of temperature $t = T/T_c$ is smaller when the transition-metal superconductor is dirtier. This relation is in qualitative agreement with the experimental findings of Lowell and Sousa. (auth)

54452 STATISTICAL MECHANICS OF ONE-DIMENSIONAL GINZBURG–LANDAU FIELDS. Scalapino, D. J. (Univ. of Cali-

fornia, Santa Barbara); Sears, M.; Ferrell, R. A. Phys. Rev., B; 6: No. 9, 3409-16(1 Nov 1972).

The statistical mechanics of one-dimensional Ginzburg–Landau fields for real, complex, and phase-only fields were studied. Results for the specific heat, the order-parameter–order-parameter, and energy-density–energy-density correlation functions, are presented. Formally, these solutions are of interest because they describe the behavior of systems which are nearly ordered but do not undergo sharp phase transitions. Physically, the real-field results may have application in some organic chain systems, while the complex field and phase-only fields are associated with superconducting strips and linear arrays of coupled weak links, respectively. (auth)

54453 SPEED OF MAGNETIC-FLUX PENETRATION INTO ELECTRICAL CONDUCTORS. Stevens, D. E.; Huebener, R. P. (Argonne National Lab., Ill.). Phys. Rev., B; 6: No. 9, 3547 (1 Nov 1972).

The pickup voltage is calculated for a flat coil sandwiched between the two halves of an infinite cylinder placed in an external periodic magnetic field. The relation between the relaxation time for flux penetration and the frequency for the maximum in pickup voltage is discussed. (auth)

54454 INVESTIGATION OF DENSITIES OF THE ELECTRON STATES FOR TWO-BAND SUPERCONDUCTOR WITH NONMAGNETIC IMPURITIES. Botoshan, N. I.; Moskalenko, V. A.; Ursu, A. M. (Inst. of Applied Physics, Moscow). Teor. Mat. Fiz.; 12: No. 2, 264-82(Aug 1972). (In Russian).

Densities of electron states $n_n(\omega)$ and the functions $\overline{n}_n(\omega)$, $m_n(\omega)$, and $\overline{m}_n(\omega)$ (similar to them) of a two-band superconductor with low as well as high concentrations of nonmagnetic impurities are calculated. The calculations are performed in the whole frequency region $\omega \geq \Omega_g$, Ω_g being the energy gap of the single-particle spectrum of the two-band superconductor. It is shown that the quantities n_1 and n_2, in the case of low concentrations of the impurity, display sharp maxima near corresponding energy gaps γ_1 and γ_2 of a pure two-band superconductor. Far from these values ($\omega = \gamma_n$) the low concentration of impurity only slightly modifies the expressions of the densities predicted by the BCS–Bogolyubov theory for pure two-band superconductor. In the case of the high concentration of nonmagnetic impurity, the functions n_n, $\overline{n}_n$, etc., of both bands are hardly distinct from each other and the densities of states display the common maximum at the frequency $\Omega_m = (\Gamma_1 N_1 + \Gamma_2 N_2)/(N_1 + N_2)$. In this limiting case the energy gap Ω_g is slightly less than Ω_m. The values of densities $n_n(\omega)$ obtained in the different frequency regions are joined together at the boundaries of these regions. (auth)

54455 EXPERIMENTAL EVIDENCE FOR THE JOSEPHSON EFFECT IN TIN FILMS. Romagnan, Jean-Pierre (Univ., Nice); Gilabert, Alain; Guyon, Etienne. Compt. Rend., Ser. B; 274: No. 25, 1343-6(19 Jun 1972). (In French).

Experimental results establishing the existence of both dc and ac Josephson effects with thin superconducting tin films are presented. These results are interpreted, making the assumption that the tin film is composed of superconducting grains coupled together by Josephson tunnel barriers or by weak bonds. (France)

54456 EXPERIMENTAL STUDY OF THE SURFACE RESISTANCE ANISOTROPY OF TYPE-II SUPERCONDUCTORS IN THE VICINITY OF H_{c3}. Baixeras, J.; Bodin, C. (Laboratoire Central des Industries Electriques, Fontenay-aux-Roses, France). J. Phys. (Paris); 33: No. 4, 407-13(Apr 1972). (In French).

The variation of the surface resistance R(H) was studied as a function of the magnetic field H for various samples of Pb–x%In, H being parallel to the sample surface and parallel or perpendicular to j_ω (electric current of the electromagnetic wave). In the latter case, fluctuations of the order parameter are excited and the slope of R(H) is smaller than in the first case. A quantitative disagreement exists between the experimental value of A_3 = (delta R/delta H) (perpendicular)/(delta R/delta H) (parallel) and the theoretical values obtained by Maki–Fischer and Thompson. Nevertheless, a significant variation of A_3 with the temperature was observed. (France)

54457 EFFECT OF THE METAL–DIELECTRIC PHASE TRANSITION ON THE SUPERCONDUCTING TRANSITION TEMPERATURE. Kopaev, Yu. V.; Timerov, R. Kh. (Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz.; 63: No. 1, 290-307 (Jul 1972). (In Russian).

A model of a metal with narrow allowed bands is investigated. Instability of the phonon system occurs in certain structures. This instability arises at higher temperatures than that in the electron system. A consequence is that crystal structure distortions of the period-doubling type arise and this leads to the metal–dielectric transition. The conditions which the electron spectrum parameters must satisfy in order that the crystal structure change simultaneously with the formation of dielectric and superconducting gaps on the Fermi surface are determined. It is found that the superconducting transition temperature may considerably exceed the respective temperature in the absence of a dielectric transformation. This is due to the high density of states near the edge of the dielectric-phase allowed bands. The main alterations in the phonon spectrum caused by the structure distortions consist in the appearance of an optical oscillation branch, which is separated from the acoustic branch by a gap. (auth)

54458 NONPERTURBATIONAL CALCULATION OF CRITICAL ANOMALIES OF SUPERCONDUCTORS IN EXTERNAL FIELDS. Koyanagi, Masao (Kyushu Univ., Fukuoka). Progr. Theor. Phys. (Kyoto); 48: No. 1, 1-18(Jul 1972).

It is shown that the application of the Kadanoff–Baym method to the Dyson equation for the fluctuation propagator allows a calculation of the dependence of critical anomalies, which come from the Aslamazov–Larkin process, on the amplitude and the frequency of the external field nonperturbationally. Calculations are presented of the excess Hall conductivity, the enhanced diamagnetism, etc. The contribution to the excess Hall conductivity from the Maki process is also calculated in the static case. (auth)

54459 STRUCTURE OF COOPER PAIRS IN SUPERCONDUCTORS. Wada, Yasushi (Tokyo Univ.). Progr. Theor. Phys. (Kyoto); 48: No. 1, 19-30(Jul 1972).

In the generalized random-phase approximation, introduced by Anderson and applied to the theory of superconductivity, existence of a collective excitation with vanishing excitation energy and momentum was known. It is shown to correspond to the creation of a Cooper pair. The creation operator satisfies a nonlinear operator equation which does not depend on the magnitude of order parameter. It is, therefore, independent of dynamics, that is, of the strength of the pairing interactions. Nevertheless it has the assumed matrix elements between a given state in an N-particle system and the corresponding state in the N + 2 particle system. Discussions are confined to the BCS superconductor at absolute zero temperature. (auth)

54460 SUPERCONDUCTIVITY. Firth, I. M. M and B Monographs. London; Mills and Boon (1972). 71p.

The following subjects are covered: basic properties (behaviour in magnetic fields, behaviour of type-I materials, behaviour of type-II materials, the mixed state); microscopic theory (the occurrence of superconductivity); enhancement of superconductivity; superconducting materials used in technology (superconducting cables); uses of superconductivity (large magnets, sensitive superconducting instruments, Josephson effect and devices). (UK)

Equipment and Devices

Refer also to abstracts 53750 and 54460.

54461 (BNL–50325) UNDERGROUND POWER TRANSMISSION BY SUPERCONDUCTING CABLE. Forsyth, E. B. (ed.) (Brookhaven National Lab., Upton, N. Y.). Mar 1972. 78p. Dep. NTIS.

Introductory materials in the fields of electric power and superconductivity are presented. Forecasts for the next 30 years are used to predict required cable characteristics and helium demand. Current research in underground cable design is reviewed including work on superconductivity in this country and abroad. BNL measurements of losses in niobium–tin at power frequencies are presented. Two conceptual superconducting flexible cables are presented. Some of the implications of using high-current cables are discussed, with particular regard to electrical characteristics, reliability, economics, cryogenic equipment design, and operation under abnormal conditions. The use of superconducting cables in dc transmission schemes is discussed, and conclusions are presented. (M.H.R.)

54462 (LNF–72/27) NUMERICAL CALCULATION OF THE ZERO BIAS CONDUCTIVITY FOR A SUPERCONDUCTING TUNNEL JUNCTION IN THE PRESENCE OF DEPAIRING. II. VOLTAGE APPLIED TO THE JUNCTION. Baker, K.; Paterno, G. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). 25 Mar 1972. 13p. Dep. NTIS (U. S. Sales Only).

A numerical calculation is presented of the differential conductance σ for a metal-insulator-superconductor tunnel junction in the presence of depairing. The calculation was made for different values of temperature and of Z (pair breaking parameter), when there is a voltage applied to the junction. The Fortran program used is presented. A table of values of σ computed by this program is given. Also included are graphs of σ as a function of

voltage V] for three values of Δ_0/KT and three values of Z. (Δ_0 is the energy gap in the absence of depairing). (M.H.R.)

54463 (ORNL-TM-3886) TECHNIQUE FOR OBSERVING MAGNET NORMALCIES. Efferson, K. R. (Oak Ridge National Lab., Tenn.). Jun 1972. Contract W-7405-eng-26. 7p. (CONF-720513-9). Dep. NTIS.

From Applied superconductivity meeting; Annapolis, MD. (1 May 1972).

A continuous fast responding linear liquid level indicator made possible the measurement of fluctuations of the surface of a liquid helium bath. Careful monitoring of the liquid helium surface was found to be useful in the IMP magnet system. The liquid surface was found to be a good indicator of heating effects, both large (coil transition) and small (flux penetration). (M.H.R.)

54464 (ORNL-TM-3921) STATE-OF-THE-ART OF SUPERCONDUCTING MAGNETS. Lubell, M. S. (Oak Ridge National Lab., Tenn.). Sep 1972. Contract W-7405-eng-26. 63p. Dep. NTIS.

A survey of the most recent developments in superconducting magnet materials is presented, and complete data on the upper critical field and transition temperature for the NbTi alloy system are given. The overall critical current density of compound conductors is shown for both low and high field commercial superconductors. A tabulation is given of high field and large bore solenoids, comparing design and test data. Comparative data are also given for some nonsolenoidal coils, and details are listed for the systems under construction or design. A criterion is derived for the stable current density attainable in extremely large magnet systems such as those envisioned for fusion reactors: $j \propto (\text{stored energy})^{-\frac{1}{2}}$. The review concludes with summaries concerning the structural materials useful in large magnets and the effects of radiation on superconducting magnets. (auth)

54465 HEAT TRANSFER TO BOILING HELIUM FROM ALUMINIUM SURFACES. Jergel, M. (Electrotechnical Inst., Bratislava); Stevenson, R. Cryogenics; 12: No. 4, 312-3(Aug 1972).

Data for heat transfer in an open pool of liquid helium at 1 atm for Al 59, 99.99% purity, compared with those for OFHC copper obtained from previous work, are presented. A marked dependence on surface orientation is shown. Since the electrical properties of OFHC copper at liquid helium temperature are comparable with those of Al 59, it is shown that from the point of view of stability of superconductors, it is more attractive to use super pure aluminium Al 69, 99.9999% purity. (UK)

54466 250 kG COMPLEX SOLENOID. Komar, E. G. (Scientific Research Inst., Leningrad). Nucl. Instrum. Methods; 103: No. 2, 235-8(1972).

The D. V. Efremov Scientific Research Institute of Electrophysical Apparatus manufactured a solenoid with the following magnetic field characteristics—the diameter is 25 mm, the length is 25 mm, the inhomogeneity is less than 2%, and the magnetic field strength in the operating region center is 250 kG. The interior of the solenoid winding is made of bronze cooled by water, the external part is made of a superconductor. The performance is continuous. (5 figures, 1 table) (auth)

PHYSICS (NUCLEAR)

Refer also to abstract 52893.

54467 (ORO-2972-204) RESEARCH IN NUCLEAR PHYSICS. Progress Report, December 1, 1970–November 30, 1971. (Texas Univ., Austin. Center for Nuclear Studies). 1971. Contract AT(40-1)-2972. 174p. Dep. NTIS.

ALUMINUM—oxygen ion reactions at 7.5 to 40 MeV, cross sections for K x-ray production in, (E)
CALCIUM—oxygen ion reactions at 7.5 to 40 MeV, cross sections for K x-ray production in, (E)
CERIUM-142—deuteron reactions (d,p) at 9 to 13 MeV, proton spectra from, (E)
COPPER—oxygen ion reactions at 7.5 to 40 MeV, cross sections for K x-ray production, (E)
DEUTERONS—interactions p + d at 800 MeV, calculation of relative neutron and pion yields in, (T)
ERBIUM-168—proton inelastic scattering at 15 MeV, proton spectra from, (E)
IRON—oxygen ion reactions at 30 MeV, Kα x-ray spectra from, (E)
KRYPTON-86—proton elastic and inelastic scattering at 4.8 to 10.1 MeV, excitation fractions for, (E)
KRYPTON-87—energy levels of, calculation of wave functions and binding energies using weak coupling model, (T)
MAGNESIUM—oxygen ion reactions at 21 MeV, Kα x-ray spectra from, (E)
MAGNESIUM-24—proton elastic and inelastic scattering at 9.7 MeV, polarization in, (E)
MOLYBDENUM-92—proton elastic scattering at 11.2 to 12.4 MeV, excitation functions for, (E)
NEON-20—deuteron reactions (d,α) at 3.5 to 8 MeV, excitation functions for, (E)
NEUTRON SPECTROMETERS—development for pulsed-beam time-of-flight studies
PROTONS—interactions p + d at 800 MeV, calculation of relative neutron and pion yields in, (T)
RUBIDIUM-87—energy levels from krypton-86 proton resonances, widths and weak coupling coefficients for isobaric analog, (E)
SILICON—oxygen ion reactions at 30 MeV, Kα x-ray spectra from, (E)
SILVER-109—deuteron reactions (d,p) at 10 MeV, proton spectra from, (E)
SODIUM-22—energy levels from resonances in neon-20 (d,α) reactions, (E)
VAN DE GRAAFF ACCELERATORS—experimental facilities for EN tandem, pulsed-beam neutron time-of-flight
X-RAY SPECTROMETERS—development of high-resolution Bragg–Soller
XENON-137—energy levels of, calculating using core coupling, (T)
ZIRCONIUM-92—proton reactions (p,α) at 28 MeV, DWBA calculation of form factors for, (T)
ZIRCONIUM-94—proton elastic scattering at 11.2 to 12.4 MeV, excitation functions for, (E)

Neutron Interactions with Matter

Refer also to abstracts 54656, 54937–54940, and 55424.

54468 (ANCR-1042) AUTOMATED CROSS SECTION ANALYSIS PROGRAM (ACSAP). Marshall, N. H.; Codding, J. W.; Simpson, O. D.; Smith, J. R.; Young, R. C. (Aerojet Nuclear Co., Idaho Falls, Idaho). Jul 1972. Contract AT(10-1)-1375. 145p. Dep. NTIS.

The Automated Cross Section Analysis Program (ACSAP) has been developed to assist in the evaluation of neutron cross section data in the resonance region. Experimental data may be compared by means of a wide selection of representations. Single level or multilevel resonance parameters may be fitted to the data by an iterative adjustment routine. Total, fission, capture, or scattering data may be fitted. The fitted curves can be printed or plotted for comparison with the data using Doppler and resolution broadening appropriate to the particular experiment. ACSAP allows each user to "program" his problem to suit his particular needs. This programmability gives ASCAP a versatility that makes it a powerful tool in cross section evaluation. ASCAP is written almost entirely in FORTRAN; however it does contain some subroutines written in IBM 360 assembly language. These are discussed in the text. ASCAP was developed using the FORTRAN H compiler with optimization level 2. This was done on an IBM 360/75 computer using 240K bytes of core and IBM 2314 disc storage. ASCAP is available through the Argonne Code Center. (auth)

54469 (ANCR-1071) CALCULATED REACTIVITY OF VINS. Brugger, R. M.; Wheeler, F. J. (Aerojet Nuclear Co., Idaho Falls, Idaho). Jun 1972. Contract AT(10-1)-1375. 18p. Dep. NTIS.

The Very Intense Neutron Source (VINS) is one proposal for an oscillated reactivity neutron booster to provide intense thermal neutron bursts for use in neutron beam research. Three-dimensional steady state neutron transport calculations have been performed for a module of the system using the Monte Carlo codes RAFFLE and KENO. These calculations have aided in the design of the system by: (1) providing an estimate of the critical mass of a module loaded with one of three fuels, i.e., ^{233}U, ^{235}U, and ^{239}Pu; (2) determining the reactivity response of the module as it passes under a fixed beryllium reflector and thus allowing a design of the reflector geometry such that a near optimum shape of reactivity oscillation is obtained; and (3) yielding an estimate of life time, component reactivity worths, leakage currents and other parameters required in the design of the system. Verification of the cross sections and codes used in the study was obtained by comparison of results from the two independent Monte Carlo codes and comparison with two critical experiments in the literature. Although these calculations are preliminary in nature they have further demonstrated the feasibility of the system and laid the groundwork for further design refinements and critical experiments necessary for further development of the system. (auth)

54470 (AREAEE-133) EXIT TUBE EFFECT UPON THE MEASURED SPACE-ENERGY NEUTRON SPECTRA. Hussein, A.; Kawi, A. Abdel; Naguib, K.; Zakharkin, I.; Hamouda, I. (Atomic Energy Establishment, Cairo (Egypt). Reactor and Neutron Physics Dept.). 1972. 26p. Dep. NTIS (U. S. Sales Only).

Perturbation effect of the exit tube is considered upon the neutron flux directed towards the flat boundary of the medium with a "black" body. On the basis of some simplifying assumptions expressions are obtained for neutron flux perturbation near the exit tube bottom. A particular case of a cadmium plate immersed in water is investigated. Comparison is made between calculations and experiment to show satisfactory agreement. Results are presented of calculating a directed neutron flux for a concrete exit tube used in the experiments on neutron flux measurements near a cadmium plate immersed in water. (auth)

54471 (CISE-R-252) RAS: A SYNTHESIS PROGRAM FOR THE CALCULATION OF 2-GROUP NEUTRON FLUX IN r-θ. Brusa, L.; Giorcelli, M.; Sclocchi, G. (Centro Informazioni Studi Esperienze, Milan (Italy)). Feb 1968. 95p. (In Italian). Dep. NTIS (U.S. Sales Only).

A code was developed which resolves the two-group neutron diffusion equations in r, θ geometry with variation synthesis of Galerkin synthesis methods. The theory of these methods and of the numerical method are developed and the acceleration of the iterative process is given. The code developed is written entirely in FORTRAN IV. Some representative examples of the use and limitations of the RAS code relative to non-localized and localized small perturbations and to large perturbations are presented. (J.S.R.)

54472 (CONF-720901–(Bks.1 and 2), pp 143-61) ADVANCES IN NEUTRON CONTINUOUS SLOWING-DOWN THEORY. Stacey, Weston M. Jr. (Argonne National Lab., Ill.). 1972.

From Meeting on new developments in reactor physics and shielding calculations; Kiamesha Lake, NY. (12 Sep 1972).

The basic equation which describes neutron slowing down contains integral terms which represent the contributions due to neutrons which have scattered from other energies. Evaluation of these scattering integrals is cumbersome and time consuming, in general. This has led to the development of approximations which allow these integrals to be evaluated by simple recursion relations or which allow the integral equation to be replaced by a more tractable differential equation. Early work on this problem was concerned with elastic moderation by heavy mass nuclei in which neutrons lost only a small increment of their energy in each collision, giving rise to the concept of "continuous slowing down." This paper begins with a review of the early theory of continuous slowing-down approximations. This

is followed by a discussion of more recent extensions and modifications of the theory. Problems associated with the treatment of resonances and anisotropy are discussed, and extensions to include inelastic scattering are reviewed. (auth)

54473 (CONF-720901–(Bks.1 and 2), pp 335-48) MECHANISM OF FAST NEUTRON TRANSPORT IN IRON. Goldstein, H.; Oblow, E.; Preeg, W.; Ching, J.; Troubetzkoy, E.; Lidofsky, L. J. (Columbia Univ., New York). 1972.

From Meeting on new developments in reactor physics and shielding calculations; Kiamesha Lake, NY. (12 Sep 1972).

The behavior of the total and partial cross sections of iron is reviewed, especially as they affect the transport of fast neutrons. It is pointed out that the non-elastic cross sections make iron a very efficient moderator at high energies. Analysis of deep penetration in reflected layers emphasizes the role of minima in the total cross section acting as effective distributed sources which provide for deep penetration. In small bare systems, the high leakage acts as an effective absorption which confines the effect of cross section structure to local penetrations only. The importance of knowing the energy distribution of secondary neutrons from non-elastic processes is underlined. (auth)

54474 (CONF-720901–(Bks.1 and 2), pp 409-17) SENSITIVITY OF CALCULATED PULSED SPHERE SPECTRA AND NEUTRON AGE TO CARBON CROSS SECTIONS. Weisbin, C. R.; Seamon, R. E.; Harris, D. R.; Stewart, L.; LaBauve, R. J.; Turner, G. D. (Los Alamos Scientific Lab., N. Mex.). 1972.

From Meeting on new developments in reactor physics and shielding calculations; Kiamesha Lake, NY. (12 Sep 1972).

In order to evaluate the adequacy of the present ENDF/B-III carbon data file (MAT1165) a series of Monte Carlo calculations were performed for both fission and monoenergetic sources. The results for neutron age and higher spatial moments are compared with other available experimental and theoretical values. The present computations were made with the ETOPL processor and the MCN Monte Carlo code. All measurements give consistently higher values for age than the calculations reported here. The precise value of the fission age is clearly sensitive to the total cross section in the keV region and below. There are no measurements or recent calculations published using ENDF/B-III data for the 14 MeV age in carbon with which to compare the present result. The value is markedly dependent upon the representation of the secondary energy distribution from the (n,n'3α) reaction, and, to a lesser extent, to the description of inelastic angular distributions. To further investigate the suitability of MAT1165 for transport calculations involving finite media, the LLL 2.9 mfp pulsed sphere experiment was calculated. All of the detail observed in the experiment is faithfully reproduced, however the calculations still lie significantly below the experimental curve. The effect of inelastic anisotropy can be clearly observed. (auth)

54475 (CONF-720901–(Bks.1 and 2), pp 1048-60) TEDIUM: IDEALIZED NEUTRON DATA FOR TESTING LIBRARY PROCESSING CODES. Raymund, Mahlon (Westinghouse Electric Corp., Pittsburgh). 1972.

From Meeting on new developments in reactor physics and shielding calculations; Kiamesha Lake, NY. (12 Sep 1972).

Nine "ETO" computer codes, generally employed as processors of ENDF/B data, were tested with a set of idealized materials called "TEDIUM." Selected tabulations of numerical results show that the ENDF/B data are well interpreted with most differences due to computer strategy features in the ETO codes. Even in the resolved resonance calculations where difficulties are greatest, agreement is usually within 2%. Consequently, reactor calculations from ENDF/B data should proceed with more confidence. Future intercomparisons of ETO results, using real ENDF/B data, are desirable. (auth)

54476 (CONF-720901–(Bks.1 and 2), pp 1063-74) FAST NEUTRON DATA, DIAGNOSIS AND PROGNOSIS. Smith, A. B. (Argonne National Lab., Ill.). 1972.

From Meeting on new developments in reactor physics and shielding calculations; Kiamesha Lake, NY. (12 Sep 1972).

The decks are not quite awash but nuclear data is settling. In itself this is of little note. However, for you whose livelihood depends upon the application of the fission process and for the future of nuclear energy it is a concern, for, without this foundation both are lost. Herein an attempt is made to diagnose the status and to estimate the prognosis of nuclear data, specifically fast neutron data. The objective is an overview indicating strengths and weaknesses in the context of fission reactor applications. The remarks are blatantly subjective with the emphasis upon experiment within a rational physical framework. (auth)

54477 (CONF-720901–(Bks.1 and 2), pp 1115-26) TEMPERATURE-DEPENDENT TRANSMISSION AND SELF-INDICATION MEASUREMENTS UPON DEPLETED U IN THE UNRESOLVED REGION. Byoun, T. Y. (Rensselaer Polytechnic Inst., Troy, N. Y.); Block, R. C.; Semler, T. 1972.

From Meeting on new developments in reactor physics and shielding calculations; Kiamesha Lake, NY. (12 Sep 1972).

Neutron transmission and self-indication ratio measurements have been carried out at the RPI LINAC on depleted U up to 100 keV in order to investigate the temperature dependence of resonance self-shielding. These measurements were performed at three sample temperatures (77°K, 295°K, and 973°K) and with sample thicknesses ranging from 0.0076 to 0.0621 atom/barn. Both stochastic sampling and analytical methods have been used to interpret these data. Average resonance parameters have been obtained and temperature dependence as well as sample thickness dependence of the data have been extensively studied. (auth)

54478 (CONF-720901–(Bks.1 and 2), pp 1127-51) BASIS OF CURRENT EVALUATED DATA FILES. Drake, M. K. (Brookhaven National Lab., Upton, N. Y.). 1972.

From Meeting on new developments in reactor physics and shielding calculations; Kiamesha Lake, NY. (12 Sep 1972).

The ENDF/B III library is described and the varying degrees of reliability represented by the different parts of the library are discussed. Some selected material from the data files are illustrated and discussed in detail. (J.W.R.)

54479 (CONF-720901–(Bks.1 and 2), pp 1152-65) FAST NEUTRON DOPPLER EFFECT. Till, C. E. (Argonne National Lab., Ill.). 1972.

From Meeting on new developments in reactor physics and shielding calculations; Kiamesha Lake, NY. (12 Sep 1972).

In this paper the Doppler effects in fast neutron spectra for the elements and isotopes measured to the present time are compiled. The status of fissile Doppler effect measurements and analytical comparisons is summarized. Finally, the Doppler effect of major practical importance, that of ^{238}U, is examined in some detail: ^{238}U Doppler effect calculations using various versions of ENDF/B data, including Version-III, are compared against measurement. The effects of both assembly and sample heterogeneity are given. Calculations of the effect on the ^{238}U Doppler effect of major changes in reactor composition (plutonium isotopic composition, sodium-voiding, presence of B_4C or B_4C plus BeO) are compared against measurement. (auth)

54480 (CONF-720901–(Bks.1 and 2), pp 1166-82) SOME RECENT DEVELOPMENTS IN RESONANCE AND DOPPLER THEORY. Hwang, Richard N. (Argonne National Lab., Ill.). 1972.

From Meeting on new developments in reactor physics and shielding calculations; Kiamesha Lake, NY. (12 Sep 1972).

This paper summarizes some recent development in resonance and Doppler theory. The first part describes the newly developed methods for treating the self-shielded cross sections in both the resolved and the unresolved energy regions. The second part describes some recent studies on the statistical treatment of the unresolved resonances. The topics discussed are the characteristics of the in-sequence overlap effect, the problems associated with the estimation of the statistical uncertainties of the calculated Doppler effect, the influence of the subthreshold structures on the Doppler effect calculations, and theory and application of the multilevel formalism. (auth)

54481 (EUR-4839) JN-METD2: A FORTRAN-IV PROGRAMME FOR SOLVING NEUTRON TRANSPORT PROBLEMS WITH ISOTROPIC SCATTERING IN MULTILAYER SLABS BY THE j_N METHOD. Asaoka, T.; Caglioti Bonanni, E. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). 1972. 57p. Dep. NTIS (U.S. Sales Only). EUR B. Fr. 85.-.

The mathematical formulas of the j_N method for the description of neutron transport in a multilayer slab system are summarized within the context of a multigroup model under the assumption that the scattering of neutrons is spherically symmetric in the laboratory system. A Fortran-IV computer program JN-METD2 is described in detail for the use of accurately solving the transport problem according to these formulas. The computer code calculates the eigenvalue of the integral transport equation, the effective multiplication factor or the asymptotic decay constant of neutrons, as well as the eigenfunction, the space, angle and energy dependent flux distribution. In addition, it evaluates the first three time moments of the time-dependent flux resulting from a delta function boundary source with space, angle and energy variables. (auth)

54482 (INR-P-1405) EFFECT OF SINGULARITIES ON APPROXIMATION IN S_N METHODS. Arkuszewski, Jacek; Kulikowska, Teresa; Mika, Janusz (Institute of Nuclear Research, Warsaw (Poland)). 1972. 25p. Dep. NTIS (U. S. Sales Only).

The discrete ordinate transport equation in two-dimensional rectangular geometry is analyzed. The exact solution is shown to exhibit singularities at the so called singular characteristic even for arbitrarily smooth cross section, source and external boundary conditions. The Box Explicit Method is proposed and used to investigate numerically the effect of the singular characteristic. (auth)

54483 (JAERI-M-4652) ANALYSIS OF PULSED NEUTRON EXPERIMENTS ON BARE FAST MULTIPLYING SYSTEM BY STORRER-STIEVENART'S THEORY. Hiraoka, Toru; Moriguchi, Kinichi; Nakano, Masafumi; Iijima, Tsutomu; Nakamura, Tomoo (Japan Atomic Energy Research Inst., Tokyo). Dec 1971. 15p. NTIS (U. S. Sales Only).

The theory by Storrer and Stievenart on the pulsed neutron experiment on fast multiplying systems has been applied by Code GS-1 to the pulsed neutron experiments on natural uranium systems and twenty percent-enriched uranium bare cores. It predicts well the time behavior of neutrons for the wide range of reactivity from the nearly critical state to the far subcritical state. (auth) (Japan)

54484 (KFK-1519) INFLUENCE OF TEMPERATURE ON THE AVERAGE NEUTRON TRANSMISSION OF GOLD IN THE UNRESOLVED RESONANCE REGION. Schneider, Eugen (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Kernphysik). Feb 1972. 75p. (In German). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Technische Hochschule, Karlsruhe (West Germany).

The influence of the temperature on the average neutron transmission of gold was studied both theoretically and experimentally at room temperature and at 800°C. For heavy nuclei individual resonances can no longer be resolved in the energy-range of 10 to 60 keV considered here. One measures averages over many resonances. To calculate those averages "artificial" resonance cross sections have to be generated by Monte-Carlo methods. The average parameters such as level-width and level-spacing are known from the resolved resonance region. The experimental transmission could only roughly be described by the resonance parameters given in the literature. Contrary to the calculations the measurements show pronounced fluctuations in the transmission. By varying the average widths and spacings we tried to fit the experimental transmissions at room temperature and at 800°C. A further measurement with good resolution showed that strong fluctuations occur in the total cross section at energies where no appropriate resonance parameters could be found. The structure near 24 keV was studied in detail and could be fitted by two broad resonances, which cannot be understood in the compound nucleus picture. (auth)

54485 (ORNL-TM-3768) INVESTIGATION OF THE ADEQUACY OF NITROGEN CROSS-SECTION SETS: COMPARISON OF NEUTRON AND SECONDARY GAMMA-RAY TRANSPORT CALCULATIONS WITH INTEGRAL EXPERIMENTS. Straker, E. A. (Oak Ridge National Lab., Tenn.). Aug 1972. Contract W-7405-eng-26. 66p. Dep. NTIS.

Two sets of cross sections for neutron interactions and secondary gamma-ray production in nitrogen, one recently evaluated by P. G. Young and D. G. Foster and another assembled in 1968 by the author, have been tested in transport calculations corresponding to integral experiments. The experiments are Operation HENRE, during which measurements were made of the neutron and gamma-ray doses produced in the atmosphere by an accelerator emitting approximately 14-MeV neutrons, and two experiments in which liquid-nitrogen-filled dewars were pulsed with approximately 14-MeV neutrons. One of the nitrogen-dewar experiments, performed at Gulf Radiation Technology, yielded the energy spectra of fast and intermediate energy neutrons and secondary gamma rays within the nitrogen, and the other, performed at Lawrence Livermore Laboratory, gave time-dependent count rates due to neutrons leaking from the nitrogen. The comparisons of the calculated and measured results showed that for Operation HENRE both cross-section sets were adequate for calculating the neutron doses but that only the old set correctly predicted the gamma-ray doses, the new set giving results that are 30 to 50% lower than the data. Conversely, the comparisons for the GRT nitrogen-dewar experiment showed that the new set gives gamma-ray spectral data that are in reasonable agreement with the data, whereas the old set overpredicts by as much as a factor of 2. For both nitrogen-dewar experiments, the new cross sections give better predictions of the neutron spectra and time-dependent neutron count rates than the old cross sections. Additional calculations with both sets of cross sections for an infinite-air medium show that the two sets give identical neutron and secondary gamma-ray doses for a fission source; they also give very similar neutron doses for a 12.2-to 15-MeV neutron source, but the secondary gamma-ray doses are in disagreement, those obtained with the newer set being 30 to 50% lower. "Sensitivity" calculations indicate that for high-energy neutron sources most of the secondary gamma rays are produced by neutrons having energies greater than 10 MeV, and the greatest difference between the two cross-section sets is their gamma-ray production probabilities at high neutron energies. On the basis of the various comparisons, it appears that the new neutron cross sections give better predictions of neutron quantities, but that a choice between the gamma-ray production cross sections is not obvious since each set agrees with one of the two gamma-ray experiments. (auth)

54486 (RISO-M-1526) BENCHMARK CALCULATIONS ON HOMOGENEOUS SPHERES. Neltrup, H. (Danish Atomic Energy Commission, Risoe. Research Establishment). Aug 1972. 12p. Dep. NTIS (U. S. Sales Only).

Results from calculations at Risø based on the 1968 UKNDL data library on ^{235}U- and ^{239}Pu-containing homogeneous spheres are compared with experimental results and calculations based on ENDF/B. Strong resemblance between the results of the two different calculations is found. Satisfactory agreement with experiments is found for the ^{235}U-containing spheres, whereas outspoken concentration dependent disagreement is found for the ^{239}Pu-containing spheres. (auth)

54487 (RT/FI-(71)37) EXPERIMENTAL MEASUREMENT OF NEUTRON GROUPS FROM PHONONS IN ZINC AT VARIOUS TEMPERATURES. De Giorgi, G.; Rizzi, G. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 6 Dec 1971. 25p. (In Italian). Dep. NTIS (U. S. Sales Only).

Measurements of thermal neutrons groups inelastically scattered from phonons in Zn monocrystal have been performed at Ispra-1 reactor at the aim to study the effects on phonon lines of the interatomic potential anharmonicity. The "Q-constant" method has been used to analyze the Σ_4 optic, the Σ_4 acoustic and the Σ_1 acoustic branches in the (OĪO) direction in the basal plane. The instruments used as well as the criteria of choosing the experimental conditions regarding resolution and focusing effects and the computing program utilized are here described. (auth)

54488 (RT/FI-(72)1)) TRUD: AN ANISOTROPIC DIFFUSION CODE FOR XY GEOMETRY. Daneri, A.; Michelini, M.; Toselli, G. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 24 Jan 1972. 273p. Dep. NTIS (U. S. Sales Only).

TRUD is an anisotropic diffusion code for neutron multigroup problems in x-y geometry, written in FORTRAN IV for the IBM 360/75. This code computes the anisotropic diffusion coefficients D_k (k = x, y, z) along the three spatial directions by the anisotropic diffusion theory and resolves the multigroup anisotropic diffusion equations. (auth)

54489 (ZJE-124) APPROXIMATION OF RESONANCE SELF-SHIELDING COEFFICIENTS. Vlachovsky, K. (Skoda Works, Pilsen (Czechoslovakia). Nuclear Power Construction Dept.). 1972. 90p. Dep. NTIS (U. S. Sales Only).

This paper gives instructions for interpolation among the resonance self-shielding coefficients published by Abagyan and others: "Group Constants for Nuclear Reactor Calculation", ATOMIZDAT, Moscow 1964. A set of interpolation formulas dependent on two parameters A, B has been worked out. Here we give the formulas as well as the tables of coefficients A, B together with the maximum relative error of the interpolation. (auth)

54490 DETECTION OF ULTRA-COLD NEUTRONS BY THE ACTIVATION OF MANGANESE. Robson, J. M.; Winfield, D. (McGill Univ., Montreal). Phys. Lett.; 40B: No. 5, 537-8 (7 Aug 1972).

The activation of manganese foils was used to detect ultracold neutrons and to measure their attenuation in helium and air. (auth)

54491 CALCULATION OF NUCLEAR REACTION RATES IN A HOMOGENEOUS SPHERE NEGLECTING ELASTIC SCATTERING. Kapyshev, V. K.; Sakharov, V. I. At. Energ. (USSR); 32: No. 6, 477-8(Jun 1972). (In Russian).

In describing nuclear-physical processes, caused by high-energy neutrons (several MeV), elastic scattering may be neglected in some cases. The possibility of disregarding elastic scattering during the calculation of nuclear reaction rates in a homogeneous sphere is investigated, where a monoenergetic neutron flux from a point source is located at the center of the sphere. As an example, a point source (14.1 MeV) was assumed at the center of a sphere of boron carbide, with the result that experimental and calculated values showed satisfactory agreement. (K.S.W.)

54492 ELEMENTARY SOLUTIONS OF THE NEUTRON TRANSPORT EQUATION TAKING INTO ACCOUNT ANISOTROPIC

SCATTERING . Sultanov, N. V. At. Energ. (USSR); 32: No. 6, 457-62(Jun 1972). (In Russian).

A complete system of plane elementary solutions of the one-velocity Boltzman equation having azimuthal asymmetry has been obtained. It is assumed that the scattering function can be expandeu into a finite series of Legendre polynomials. A simultaneous consideration of the azimuthal dependence of the elementary solutions and anisotropic scattering has been undertaken for the first time in this work. Furthermore, the transcendental characteristic equations have been derived and the number of roots of these equations estimated. The orthogonality and completeness of the obtained system of elementary solutions are proved. Several cells were calculated in accordance with the modified code "PRAKTINETS." (auth)

54493 STUDY OF COLD NEUTRON SPECTRA EMERGING FROM SOURCES OF LIQUID HYDROGEN AND DEUTERIUM AND A MONTE CARLO METHOD FOR OPTIMISATION. Carter, P.; Jones, D. M. (Atomic Energy Research Establishment, Harwell, Eng.). J. Nucl. Energy; 26: No. 5, 237-49(May 1972).

Measurements of the moderating efficiency of cold neutron sources (with simple transmission geometry) containing liquid hydrogen, liquid deuterium and mixtures of the two are described. A Monte Carlo method of calculating the cold neutron outputs was devised and calculations based on the theoretical cross sections of Young and Koppel satisfactorily reproduced the experimental spectrum shapes, optimum depths of moderator and cold neutron outputs. This method is quite adequate for optimising the design of future cold sources (±20%). It was found that the calculated deuterium cross sections must be modified for wavelengths beyond 5 Å so that the total cross sections correspond to the measured values of Seiffert (adjusted to the operating temperature). (UK)

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Refer also to abstracts 54602, 54656, and 54715.

54494 (COO-3001-15) MAGNETIC MOMENTS OF ^{3}H AND ^{3}He IN THE QUARK MODEL. Ichimura, M.; Hyuga, H.; Brown, G. E. (State Univ. of New York, Stony Brook. Dept. of Physics). 1972. Contract AT(11-1)-3001. 36p. Dep. NTIS.

The magnetic moments of ^{3}H and ^{3}He were investigated by treating the nucleons N and nucleon resonance states N*(1236 MeV) on the same footing. The quark model is used to determine potentials and magnetic moment operators operating on states consisting of N and/or N*. It is found that strong cancellations take place between effects from wave function renormalization and cross terms between N and N* states. Hence, even a sizable N* component does not shift the magnetic moments of ^{3}H and ^{3}He much from their Schmidt values. Further the two-N* state in trinucleon system as well as the one-N* state were taken into account. The two body exchange magnetic moments coming from the so-called Born term, including the contributions from the transition between the S state and the D state, the S state and the one-N* state and the S state and the two-N* state were also evaluated. They are all additive with the same sign. The calculated values of the isoscalar and the isovector parts are $\mu^s_{cal} = 0.42 \sim 0.43$ and $\mu^v_{cal} = 2.61 \sim 2.67$, which are close to the experimental values $\mu^s_{exp} = 0.426$ and $\mu^v_{exp} = 2.553$. Corrections to the β-decay amplitude are discussed briefly. (auth)

54495 (EUR-4765, pp 435-55) PRECISE ATOMIC MASS MEASUREMENT AT OSAKA UNIVERSITY. Ogata, K. (Osaka Univ.).

From second conference on mass spectrometry; Ispra, Italy (1 Sep 1971).

A brief historical survey of atomic mass measurements is presented. Some recent work at Osaka University is surveyed. Some very precise results for H, D, and ^{35,37}Cl are discussed. (J.W.R.)

54496 (ITF-72-24-P) ON TWO-PARTICLE ELECTRODESINTEGRATION OF THE ^{3}He. Kozlovskii, I. V.; Tartskovskii, V. K.; Fursa, A. D. (Akademiya Nauk Ukrainskoi SSR). 1972. 20p. (In Russian). Dep. NTIS (U. S. Sales Only).

General formulas for the two-particle electrodisintegration cross section of ^{3}He in terms of the matrix elements of radial wave functions of the ^{3}He and proton-deuteron systems are obtained. Calculations were performed using the Gaussian wave function for the ground state of ^{3}He and the final-state wave function included the interaction between the resulting proton and deuteron. It is shown that in many cases the ^{3}He electrodisintegration cross section depends essentially on the final-state interaction. (auth)

54497 (LA-DC-72-876) ACCURATE DEUTERON-DEUTERON ELASTIC SCATTERING CROSS SECTIONS. Jarmie, Nelson; Jett, J. H. (Los Alamos Scientific Lab., N. Mex.). [nd]. 4p. (CONF-720819-5). Dep. NTIS.

From International conference on few particle problems in nuclear interactions; Los Angeles, CA. (28 Aug 1972).

Differential cross sections for deuteron-deuteron elastic scattering were made at 12.305 MeV with relative errors of 0.5% and a scale error of about 0.4%. The measurements were made at 2.5° intervals from 10 to 50° in the laboratory system. The results are compared with previous data. (J.W.R.)

54498 (LA-DC-72-904) PRELIMINARY MEASUREMENTS OF POLARIZATION TRANSFER IN ^{4}He(d, $\vec{d}$)^{4}He ELASTIC SCATTERING. Salzman, G. C.; Ohlsen, Gerald G.; Mitchell, C. K.; Grueebler, W.; Simon, W. G. (Los Alamos Scientific Lab., N. Mex.). [nd]. 4p. (CONF-720819-8). Dep. NTIS.

From International conference on few particle problems in nuclear interactions; Los Angeles, CA. (28 Aug 1972).

Polarization transfer measurements for polarized deuteron elastic scattering by ^{4}He were made. Data were taken at a laboratory deuteron angle of 30° and at deuteron energies of 4.8, 6.3, 7.7, and 8.6 MeV. The measurements are adequate to allow an unambiguous determination of the scattering matrix. (J.W.R.)

54499 (LA-DC-72-905) VECTOR TO TENSOR POLARIZATION TRANSFER IN PROTON-DEUTERON ELASTIC SCATTERING. Ohlsen, Gerald G.; Mitchell, C. K.; Salzman, G. C. (Los Alamos Scientific Lab., N. Mex.). [nd]. 4p. (CONF-720819-7). Dep. NTIS.

From International conference on few particle problems in nuclear interactions; Los Angeles, CA. (28 Aug 1972).

Analyzing power, polarization functions, and vector to tensor polarization coefficients for proton elastic scattering by deuterium were measured at proton energies of 3.6 to 9.1 MeV. (J.W.R.)

54500 (LA-DC-72-906) ANALYZING POWERS IN THE ^{3}He(d̄,p)^{4}He REACTION AT ENERGIES LESS THAN 1.0 MeV. Simon, W. G.; Mitchell, C. K.; Ohlsen, Gerald G. (Los Alamos Scientific Lab., N. Mex.). [nd]. 4p. (CONF-720819-9). Dep. NTIS.

From International conference on few particle problems in nuclear interactions; Los Angeles, CA. (28 Aug 1972).

Analyzing tensors were measured for the ^{3}He(d̄,p) reaction for deuteron energies between 366 and 1090 keV. The results are compared with other data. Some conclusions regarding the contribution of partial waves higher than s waves are drawn. (J.W.R.)

54501 (ORNL-TM-3910) COMPARISON OF (n_{th},γ) YIELDS FROM THE CURRENT ENDF/B-III DATA WITH PUBLISHED DATA. Ford III, W. E. (Oak Ridge National Lab., Tenn.). Aug. 1972. Contract W-7405-eng-26. 29p. (ENDF-172). Dep. NTIS.

As a first check of the ENDF/B-III photon production data available as of June 1972, the number of photons per thermal-neutron capture was calculated for 50 keV gamma-ray bins and compared with published data. This comparison was done for ^{1}H(MAT 1148), ^{9}Be(1154), ^{14}N(1133), ^{16}O(1134), ^{23}Na(1156), ^{27}Al(1135), Si(1151), Cl(1149), K(1150), Ca(1152), Fe(1180), and Pb(1136). (auth)

54502 (SC-RR-720513) THICK TARGET YIELD CALCULATIONS FOR STRONG NEUTRON-PRODUCING REACTIONS IN THE ENERGY RANGE 30 keV TO 1.5 MeV. Wilson, W. D.; Crawford, J. C. (Sandia Labs., Albuquerque, N. Mex.). Aug 1972. 28p. Dep. NTIS.

A combination of the Lindhard, Scharff, and Schiott (LSS) theory and a modified Bethe theory is used to calculate electronic stopping power. These results, combined with available reaction cross section data, are used to calculate thick target neutron yields from various neutron reactions in an ion accelerator. The reactions considered are ^{2}H(d,n)^{3}He, ^{2}H(t,n)^{4}He, ^{3}H(d,n)^{4}He, ^{6}Li(d,n)^{7}Be, ^{7}Li(d,n)^{8}Be, ^{9}Be(d,n)^{10}B chosen because of their large reaction cross sections in the energy range 30 keV to 1.5 MeV. Sample calculations are presented and compared to available experimental results and previous calculations over a more limited energy range. (auth)

54503 (UCRL-74069) NUCLEON-NUCLEON SCATTERING LENGTHS FROM INCOMPLETE NUCLEON-DEUTERON BREAKUP EXPERIMENTS. Davis, J. C.; Anderson, J. D.; Grimes, S. M.; Wong, C. (California Univ., Livermore. Lawrence Livermore Lab.). 16 Aug 1972. 4p. (CONF-720819-2). Dep. NTIS.

From International conference on few particle problems in nuclear interactions; Los Angeles, CA. (28 Aug 1972).

Time-of-flight techniques were used to measure neutron spectra from the D(p,n)2p reaction at nine proton energies between 16 and 26 MeV. The impulse approximation was used to extract the p-p scattering length from the data. The same formalism was then

applied to the D(n,p)2n reaction to obtain information on the n-n scattering length. (J.W.R.)

54504 TRINUCLEON PROPERTIES WITH RIIHIMAKI POTENTIAL. Nunberg, P. (Comitato Nazionale per l'Energia Nucleare, Rome); Prosperi, D.; Pace, E. Phys. Lett.; 40B: No. 5, 529-32(7 Aug 1972).

The binding energy and D-state probability of ^{3}H and the charge radii of ^{3}H and ^{3}He are computed using a realistic nucleon–nucleon potential which features a very soft (local plus separable) core. (auth)

54505 D(p,2p)n REACTION AT 51.8 MeV. Sanada, J. (Tokyo Univ. of Education); Seki, S.; Oryu, S. Phys. Lett.; 40B: No. 5, 546-8(7 Aug 1972).

The results of the deuteron breakup by protons, measured in coplanar symmetric geometry at forward angles, were compared with calculations based on the three-body Faddeev formalism and other theories. (auth)

54506 MESON-EXCHANGE CURRENTS AND ^{3}H, ^{3}He MAGNETIC MOMENTS. Harper, E. P. (Purdue Univ., Lafayette, Ind.); Kim, Y. E.; Tubis, A.; Rho, M. Phys. Lett.; 40B: No. 5, 533-6(7 Aug 1972).

It is shown that the discrepancies between the experimental ^{3}H, ^{3}He magnetic moments and single-particle values are very nearly accounted for by two-nucleon one-pion-exchange contributions. About two-thirds of the discrepancy in the isovector magnetic moment is given by trinucleon S–D matrix elements. (auth)

54507 CENTER OF MASS SPURIOSITY EFFECTS ON THE CHARGE FORM FACTOR IN MANY-BODY THEORIES. Gareev, F. A. (Joint Inst. for Nuclear Research, Dubna, USSR); Palumbo, F. Phys. Lett.; 40B: No. 6, 621-4(21 Aug 1972).

The effect of c.m. spuriosity on the charge form factor of the nuclei ^{4}He and ^{16}O is studied by assuming Saxon–Woods wave functions as selfconsistent wave functions. It is found that this effect is quite large at high momentum transfer. (auth)

54508 ARE THE SOLAR-NEUTRINO EXPERIMENTS SUGGESTIVE OF THE EXISTENCE OF A RESONANCE IN THE ^{3}He + ^{3}He SYSTEM? Fetisov, V. N. (Lebedev Inst. of Physics; Moscow); Kopysov, Yu. S. Phys. Lett.; 40B: No. 6, 602-4(21 Aug 1972).

The possibility of the existence of a resonance in the ^{3}He + ^{3}He system, which may be important for explaining the solar-neutrino experiments, is discussed. (auth)

54509 EXACT CALCULATIONS OF N–d POLARIZATION. Doleschall, P. (Central Research Inst. for Physics, Budapest); Aarons, J. C.; Sloan, I. H. Phys. Lett.; 40B: No. 6, 605-6(21 Aug 1972).

The recent N–d polarization calculations of Doleschall and of Aarons and Sloan are compared (after performing the former calculation at 10.85 MeV), and are found to agree well. The theoretical calculations, however, are in complete conflict with the experimental results. (R.W.R.)

54510 POSSIBLE INTERPRETATION OF THE DIFFERENCE BETWEEN THE d(p,2p)n AND d(p,pn)p CROSS SECTIONS. Mithra, B.; Laverriere, R. (Univ. Claude Bernard, Villeurbanne, France). Phys. Lett.; 41B: No. 1, 11-12(4 Sep 1972).

It is shown that the cross-section difference between the reactions d(p,2p)n and d(p,pn)p for small momentum transfer can be interpreted by means of a polar graph if the same pole value is not taken for the two reactions; this possibility is by the theory. (auth)

54511 RESCATTERING EFFECTS IN THE ^{2}H(p,2p)n AND ^{2}H(p,pn)n REACTIONS INDUCED BY 20- TO 60-MeV PROTONS. Durand, J. L.; Arvieux, J.; Fiore, A.; Perrin, C.; Durand, M. (Institut des Sciences Nucleaires, Grenoble, France). Phys. Rev., C; 6: No. 2, 393-403(Aug 1972).

The (p,p) and (n,p) quasifree scatterings have been studied in the same experiment. The data are compared with single-scattering models and with calculations of the rescattering series up to the third order. Single-scattering calculations give the shape of the spectra, but there is a discrepancy between calculated and experimental absolute values of the cross sections. Calculations of the rescattering effect do not converge below 20 MeV but reproduce both the magnitude and the shape of the quasifree peak above 40 MeV. (auth)

54512 ELASTIC SCATTERING OF 600-MeV PROTONS FROM H, D, ^{3}He, AND ^{4}He). Boschitz, E. T. (Lewis Research Center, Cleveland); Roberts, W. K.; Vincent, J. S.; (and others). Phys. Rev., C; 6: No. 2, 457-66(Aug 1972).

The elastic scattering of 600-MeV protons from light nuclei has been studied at the National Aeronautics Space Administration Space Radiation Effects Laboratory (SREL) synchrocyclotron. Differential cross sections have been obtained for the scattering of protons from hydrogen, deuterium, helium-3, and helium-4. Polarization was measured for deuterium and ^{4}He nuclei. The p-p cross-section data are in excellent agreement with the predictions from the Livermore phase shifts. Small-angle p-D, p-^{3}He elastic scattering data are compared with calculations based on the multiple-scattering theories of Watson and Glauber. (auth)

54513 ANALYSIS OF PHASE SHIFTS OF p–d ELASTIC SCATTERING AT 2.0, 2.7, 3.3, AND 3.8 MeV. Schmelzbach, P.-A.; Saratz, G.; Grueebler, W.; (and others) (Eidgenoessisches Technische Hochschule, Zurich). Helv. Phys. Acta; 45: 52-4(1972). (In French).

The formalism used for the phase-shift analysis takes account of non-degeneracy in J and the coupling due to nonconservation of the orbital angular momentum and the spin. Partial waves up to L = 4 are considered; however, the phase shifts of F and G waves are not separated in J. The introduction of coupling is not necessary for the adjustment of the cross sections, the polarization of the protons, or iT_{11}. It is indispensable, on the other hand, for the correct reproduction of the tensor analyzing powers, in particular for T_{21}. With the exception of the doublets ^{2}P and ^{2}D, the phase shifts obtained differ little from those found previously. The most important coupling is observed between the $^3S_1$ and $^4D_1$ states and between the $^4P_1$ and $^2P_1$ states. (2 figures) (R.W.R.)

54514 ^{4}He–^{4}He INTERACTION POTENTIAL FROM LOW ENERGY TOTAL CROSS SECTION MEASUREMENTS. Bennewitz, H. G.; Busse, H.; Dohmann, H. D.; Oates, D. E.; Schrader, W. (Univ., Bonn). Z. Phys.; 253: No. 5, 435-57(1972).

Total relative and absolute cross sections for ^{4}He–^{4}He were measured between 110 and 1100 m/s velocity of the primary beam at scattering chamber temperatures of 5.0 and 77°K. The measurements were sensitive to the low-energy repulsive and the attractive part of the potential. The resulting potential is able to describe scattering measurements of other authors; it is also in very good agreement with ab initio calculations of Bertoncini and Wahl. (auth)

54515 TWO SEARCHES FOR AN EXCITED STATE OF ^{3}He. Frisbee, P. E.; Pugh, H. G. (Univ. of Maryland, College Park). Nucl. Phys.; A191: No. 3, 658-62(1972).

The ^{3}He(α,α')^{3}He* reaction was studied at 115 MeV, and the ^{4}He(p,d)^{3}He* reaction was studied at 65 MeV. The ^{3}He continuum spectra show no evidence for production of an excited state of ^{3}He at 20.4 MeV. (2 figures, 2 tables) (auth)

54516 FOUR-NUCLEON STUDIES. I. REDETERMINATION OF THE NEUTRON POLARIZATION FOR THE ^{2}H(d,$\vec{n}$)^{3}He REACTION FROM 6 TO 14 MeV. Spalek, G.; Hardekopf, R. A.; Taylor, J. Jr.; Stammach, Th.; Walter, R. L. (Duke Univ., Durham, N. C. Triangle Universities Nuclear Lab., Durham, N. C.). Nucl. Phys.; A191: No. 3, 449-59(1972).

An accurate redetermination of the angular distribution for the polarization of the neutrons produced in the ^{2}H(d,$\vec{n}$)^{3}He reaction was obtained for deuteron energies of 6, 8, 10, 12, and 14 MeV. The differential polarization $P_1(\theta)\sigma(\theta)$ was fitted at each energy by using two and three terms in an associated Legendre function expansion. Data at 18 MeV from another report were also fitted, and only at this energy was the third term required. The present data are consistent with earlier data below 10 MeV, but at 12 and 14 MeV P_1 (45° cm) is about 50% higher than the previous measurements. (3 figures, 3 tables) (auth)

54517 FOUR-NUCLEON STUDIES. III. MEASUREMENT OF THE ^{2}H(d,$\vec{p}$)^{3}H POLARIZATION VIA THE ^{3}H($\vec{p}$,d)^{2}H REACTION AND COMPARISON TO POLARIZATION IN ^{2}H(d,$\vec{n}$)^{3}He. Hardekopf, R. A. (Duke Univ., Durham, N. C. Triangle Universities Nuclear Lab., Durham, N. C.); Lisowski, P. W.; Rhea, T. C.; Walter, R. L.; Clegg, T. B. Nucl. Phys.; A191: No. 3, 468-80 (1972).

Accurate angular distributions of the analyzing power in the ^{3}H($\vec{p}$,d)^{2}H reaction were measured at eight energies from 6.7 to 14.7 MeV. By reciprocity, these analyzing powers are the same as the proton polarizations of the ^{2}H(d,$\vec{p}$)^{3}H reaction from 2.0 to 14.0 MeV. The products $P_1(\theta)\sigma(\theta)$ were fitted with a series of even-order associated Legendre functions, and two terms in the series were found to be sufficient to describe the reaction up to 14 MeV. Comparisons are made with the polarizations from the mirror reaction ^{2}H(d,$\vec{n}$)^{3}He, and good agreement is found when the reactions are compared at the same exit-channel energies. The implications of this are discussed in the light of other recent comparisons which suggest that differences in these mirror reactions may be a violation of charge symmetry of nuclear forces. (5 figures, 2 tables) (auth)

54518 FOUR-NUCLEON STUDIES. IV. ANALYZING POWERS IN THE ELASTIC SCATTERING OF PROTONS FROM TRIT-

IUM. Hardekopf, R. A. (Duke Univ., Durham, N. C. Triangle Universities Nuclear Lab., Durham, N. C.); Lisowski, P. W.; Rhea, T. C.; Walter, R. L.; Clegg, T. B. Nucl. Phys.; A191: No. 3, 481-8(1972).

Analyzing powers with statistical uncertainties of approximately 0.005 were measured for $^3H(\vec{p},p)^3H$ elastic scattering by using a proton beam from a polarized-ion source. Angular distributions with about twenty points for angles from 25 to 160° were obtained for E_p = 9.4, 10.7, 12.0, 13.4 and 14.7 MeV. Partial distributions for the range from 110 to 160° were obtained for E_p = 6.7, 7.4, and 8.0 MeV. The data were parametrized in terms of complex phase shifts. (3 figures) (auth)

54519 MEASUREMENT OF ISOTOPIC RATIOS OF HELIUM. Boulloud, J. P.; Michel, S.; Tauveron, P. (CEA-DAM, Montrouge, France). J. Mass Spectrom. Ion Phys.; 9: No. 4, 375-85(Sep 1972). (In French).

Isotopic ratios of the order of 10^{-6} of various samples of helium were determined using a double focusing mass spectrometer. To obtain an accurate count of $^3He^+$ ions, reproducible results may be obtained from the separate collection of the counts of the two isotopes and by combining the results. The reproducibility attained with atmospheric helium gave a spread of less than 0.6%. Possible applications of this technique are discussed. (auth)

54520 n + d BREAK-UP REACTION WITH SEPARABLE POTENTIALS. Ebenhoeh, Wolfgang (Max-Planck-Institut fuer Kernphysik, Heidelberg). Nucl. Phys.; A191: No. 1, 97-117 (1972).

A new technique to calculate the n + d break-up cross sections with separable potentials is presented. Similar calculations were made earlier by Cahill and Sloan (Nucl. Phys., A165: (1971)). Some results of the calculations for many kinematically complete n + d and p + d break-up experiments are given. The agreement is very good. An easily maneuverable computer program exists for the matrix elements. (auth)

54521 POLARIZATION AND CROSS SECTION OF p + ^3H ELASTIC SCATTERING AT 19 AND 30 MeV. Darves-Blanc, R.; Nguyen Van Sen; Arvieux, J.; (and others) (Institut des Sciences Nucleaires, Grenoble, France). Nucl. Phys.; A191: No. 2, 353-60(1972). (In French).

With a polarized proton beam, the differential cross section and the proton analyzing power of the p + ^3H elastic scattering at 19 and 30 MeV have been measured and compared to the p + ^3He data. The proton analyzing power of the latter scattering has also been measured at 30 MeV to supplement the existing data. Real phase shifts from a preliminary analysis are deduced for both of the scatterings. (auth)

54522 $^2H(p,2p)n$ REACTION AT 115 MeV FOR HIGH MOMENTUM TRANSFERS AND THE OFF-ENERGY-SHELL NUCLEON-NUCLEON INTERACTION. Morlet, M.; Frascaria, R.; Marty, N.; Willis, A. (Institut de Physique Nucleaire, Orsay, France). Nucl. Phys.; A191: No. 2, 385-98(1972).

The $^2H(p,2p)n$ cross sections have been measured for kinematical conditions where the energy in the exit channel is nearly equally shared between the three particles. When interpreted in terms of the nucleon-nucleon interaction, this condition leads to significant off-shell terms. A comparison is made with theoretical values computed for different nucleon-nucleon potentials which appear to show important differences. (auth)

Nuclear Properties and Reactions, 6 ≤ A ≤ 19

Refer also to abstracts 53804, 54238, 54351, 54501, 54502, 54507, 54508, 54602, 54683, 54713, 54714, 54716, 54745, and 54747.

54523 (CONF-720901-(Bks.1 and 2), pp 325-34) SECONDARY GAMMA-RAY-PRODUCTION CROSS SECTIONS OF SEVERAL MATERIALS. Morgan, G. L.; Dickens, J. K.; Love, T. A.; Perey, F. G. (Oak Ridge National Lab., Tenn.). 1972.

From Meeting on new developments in reactor physics and shielding calculations; Kiamesha Lake, NY. (12 Sep 1972).

Absolute gamma-ray-production cross sections have been measured as a function of both incident neutron and emitted gamma-ray energy for tantalum, iron, silicon, and carbon. The data include gamma-ray energies between 0.7 and 10.6 MeV for incident neutron energies up to 20 MeV. Measurements were made at angles of 90° and 125° for tantalum and carbon and at 125° for iron and silicon. Detailed tables of cross sections have been transmitted to the National Neutron Cross Section Center. (auth)

54524 (COO-2171-14) HOW GOOD IS THE HARTREE-FOCK APPROXIMATION FOR ^{16}O? Parikh, J. C. (Rochester Univ., N. Y. Dept. of Physics and Astronomy. Physical Research Lab., Ahmedabad (India)); Svenne, J. P. (Manitoba Univ., Winnipeg. Dept. of Physics). 1971. Contract AT(11-1)-2171. 13p. (UR-406). Dep. NTIS.

Hartree–Fock intrinsic states in ^{16}O are examined to find out the extent to which they are good approximations to the exact eigenstates of the system. For this purpose the notion of width of a state is introduced. In terms of the width it is found that by itself the Hartree–Fock approximation is not good in ^{16}O, however it does provide a suitable basis to discuss the structure of the low-lying states. The calculation of the 0^+ levels confirms earlier suggestions made regarding the nature of these levels and is also in agreement with exact calculations done in a small basis space. (auth)

54525 (FRNC-TH-191) MEASUREMENT OF THE DEPOLARIZATION PARAMETER, D, IN THE ELASTIC SCATTERING OF PROTONS BY ^9Be, ^{10}B, AND ^{27}Al. Schnabel, Peter (Paris Univ., Orsay (France)). 1971. 68p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

In order to establish the existence of a possible dependence on the spin of the nucleus, the scattering of polarized protons by targets having nuclei of nonzero spin (^{27}Al, ^9Be, ^{10}B) was studied. Measurement of the depolarization parameter, D, enabled the percentage of scattering with spin flip in the elastic scattering of protons to be determined. The following percentages were determined: 1.8 ± 1.1 for ^{27}Al, 3.0 ± 0.8 for ^9Be, and 3.7 ± 0.6 for ^{10}B. By attributing the spin-flip effect to the action of a spin-spin force, the parameters of the corresponding potential in the framework of the optical model can be determined. This was done for ^{27}Al and ^9Be. The results obtained indicate a possible dependence of the potential on 1/A. (France)

54526 (ITF-72-25-P) ON THE QUASI-ELASTIC ELECTRON SCATTERING ON THE ^{12}C NUCLEI. Fursa, A. D.; Tartakovskii, V. K.; Kozlovskii, I. V. (Akademiya Nauk Ukrainskoi SSR). 1972. 15p. (In Russian). Dep. NTIS (U. S. Sales Only).

Inelastic fast-electron scattering on ^{42}C when only a scattered electron is experimentally fixed is considered. The spectral distributions of two-particle correlation functions for ^{42}C have been calculated to express the cross section of the process. The oscillator shell model without spin-orbit interaction is used for the description of ^{42}C. A method weakening the dependence of the electron spectra obtained on some assumptions of the nuclear model has been used in calculations to obtain a satisfactory agreement with experimental data. (auth)

54527 (LYCEN-7219) (d,^6Li) REACTIONS WITH LIGHT NUCLEI AT 28 MeV. Bedjidian, M.; Chevallier, M.; Grossiord, J. Y.; Guichard, A.; Gusakow, M.; Pizzi, J. R.; Ruhla, C. (Lyon Univ. (France). Institut de Physique Nucleaire). [nd]. 12p. (In French). Dep. NTIS (U. S. Sales Only).

The (d,^6Li) reactions with ^{12}C, ^{16}O, ^{19}F and ^{40}Ca were studied at 28 MeV. The angular distributions were obtained between 4 deg and 70 deg (cms) for the ground states and two excited-state transitions. A DWBA analysis was made assuming the transfer of an alpha particle in the zero range approximation. Relative spectroscopic factors were compared to Yoshida's calculations. (France)

54528 (NASA-TM-X-2440, pp 523-6) ACCELERATOR MEASUREMENT OF THE ENERGY SPECTRA OF NEUTRONS EMITTED IN THE INTERACTION OF 3-GeV PROTONS WITH SEVERAL ELEMENTS. Nalesnik, W. J.; Devlin, T. J.; Merker, M.; Shen, B. S. P. (Univ. of Pennsylvania, Philadelphia). Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

The shapes of the energy spectra of neutrons between 20 and 400 MeV emitted at 20, 34, and 90° in the bombardment of C (1.8 g cm^{-2}), Al (1.7 g cm^{-2}), Co (4.4 g cm^{-2}), and Pt (81.5 g cm^{-2}) targets by 3-GeV protons were measured by time-of-flight techniques. (auth)

54529 (RPP/NS-8) RATIO OF PION-NUCLEUS REACTION CROSS-SECTIONS AND THE NEUTRON DENSITY DISTRIBUTION FOR LEAD. Allardyce, B. W.; Batty, C. J.; Baugh, D. J.; (and others) (Rutherford High Energy Lab., Chilton (England)). 1972. 10p. Dep. NTIS (U. S. Sales Only).

The ratio of the reaction cross-sections for π^- and π^+-mesons was measured for a series of nuclei over the momentum range from 0.71 to 2.0 GeV/c. An analysis of the results for C and Pb is presented and compared with the predictions of a variety of nuclear models. (auth) (UK)

54530 ANALYSIS OF 20 GeV PROTON–NUCLEI SCATTERING. Sood, P. M. (Panjab Univ., Chandigarh, India); Tuli, S. K. Nucl. Phys.; A187: No. 1, 153-60(1972).

The semi-empirical model for the elastic and quasi-elastic scattering of nucleons by nuclei in the GeV region, proposed by Steenberg, has been applied for the analysis of data for the scattering of ≈20 GeV protons from the light nuclei ^{9}Be and ^{12}C and the medium weight nucleus ^{27}Al. The agreement between the model and the scattering data has been found to be fairly reasonable. Also, in the case of light nuclei, the best-fit parameter x concerning the ratio of the real and imaginary parts of the proton-nucleus scattering amplitude agrees well with the ratio γ between the real and imaginary parts of the p-nucleon forward-scattering amplitude at this energy. (auth)

54531 GIANT DIPOLE RESONANCE IN ^{16}O OBSERVED WITH THE POLARIZED PROTON CAPTURE REACTION. Hanna, S. S.; Glavish, H. F.; Diener, E. M.; (and others) (Stanford Univ., Calif.). Phys. Lett.; 40B: No. 6, 631-4(21 Aug 1972).

The giant E1 resonance of ^{16}O was studied with the polarized proton capture reaction ^{15}N($\vec{p}$,γ_0)^{16}O. The asymmetry produced in the angular distribution by the proton polarization was large and remarkably constant over the structure of the giant resonance. Combined with unpolarized measurements, the polarized results provide additional information on the configuration of the giant E1 resonance in ^{16}O. (auth)

54532 HIGH-ENERGY LIMIT FOR THE α–d AND τ–t FORM FACTORS IN THE ^{6}Li NUCLEUS AND THE PROBLEM OF EXPERIMENTAL INVESTIGATION OF THE NODES OF THE CORRESPONDING WAVE FUNCTIONS. Kurdyumov, I. V.; Neudatchin, V. G.; Yu. F.; Korennoy, V. P. (Inst. of Nuclear Physics, Moscow). Phys. Lett.; 40B: No. 6, 607-10(21 Aug 1972).

The cluster-model form factors α–d and τ–t of the ^{6}Li nucleus were calculated in analytical form. The optical-potential description of the corresponding scattering phases is given. The Young scheme [42] involves only even τ–t phases; and the Young scheme [33], only odd ones. (auth)

54533 CONTRIBUTION OF RECTANGULAR GRAPHS IN THE REACTION ^{14}N(^{3}He,p)^{16}O* (E* = 8.88 MeV). Allard, J. F.; Amiel, M. (Institut d'Etudes Nucleaires, Algiers). Phys. Lett.; 41B: No. 1, 29-30(4 Sep 1972).

Possible evidence of the manifestation of rectangular graphs is presented in the reaction ^{14}N(^{3}He,p$_5$)^{16}O* (E* = 8.88 MeV) in a region where such mechanisms were not expected. (auth)

54534 ^{16}O + ^{12}C QUASIMOLECULAR STATES. Nagorcka, B. N.; Newton, J. O. (Australian National Univ., Canberra). Phys. Lett.; 41B: No. 1, 34-8(4 Sep 1972).

Resonances in the total reaction yield of the ^{16}O + ^{12}C reaction cannot be explained in terms of statistical fluctuations and, as for the ^{12}C + ^{12}C reaction, could be quasi-molecular in nature. These resonances were interpreted as single-particle resonances in a complex optical potential well, good qualitative agreement with the data was obtained. (auth)

54535 PIONIC PROTON STRIPPING AND π^- PRODUCTION. Rohlin, J. (Inst. of Physics, Goeteborg); Gabathuler, K.; Tanner, N. W.; Cox, C. R.; Domingo, J. J. Phys. Lett.; 40B: No. 5, 539-42(7 Aug 1972).

Evidence was obtained for the reaction ^{9}Be(p,π^-)^{10}C, by using 600-MeV protons and a magnetic spectrometer at 0° for the pions. This reaction is forbidden in the "pionic proton stripping" description of the mirror reaction ^{9}Be(p,π^+)^{10}Be. The cross section for π^- production is approximately 100 times smaller than that for π^+ production. (auth)

54536 RADIATIVE KAON CAPTURE BY NUCLEI. Korenman, G. Ya.; Popov, V. P. (Inst. of Nuclear Physics, Moscow). Phys. Lett.; 40B: No. 6, 628-30(21 Aug 1972).

The process of the radiative kaon capture by nuclei is considered. The total yields of γ quanta corresponding to the production of different hyperons are calculated. (auth)

54537 NEGATIVE MUON CAPTURE IN CARBON LEADING TO SPECIFIC FINAL STATES. Miller, G. H.; Eckhause, M.; Kane, F. R.; Martin, P.; Welsh, R. E. (Coll. of William and Mary, Williamsburg, Va.). Phys. Lett.; 41B: No. 1, 50-2(4 Sep 1972).

The yields of γ rays from specific final nuclear states excited following negative muon capture in ^{12}C were measured. By using the values for the capture rates to excited states in ^{12}B and the result of an earlier experiment for the total capture to all bound states in ^{12}B, the direct capture rate to the ground state of ^{12}B is found to be $\lambda(^{12}B_{gs}) = (6.0 \pm 0.4) \times 10^3\ s^{-1}$. This value is in agreement with theoretical predictions, but the theoretical and experimental uncertainties permit extraction of only a rather imprecise value for the weak-magnetism coupling constant in the muon-capture Hamiltonian. (auth)

54538 OFF-SHELL EFFECTS IN THE ^{18}O AND ^{18}F SHELL-MODEL SPECTRA. Pradhan, H. C.; Sauer, Pu.; Vary, J. P. (Massachusetts Inst. of Tech., Cambridge). Phys. Rev., C; 6: No. 2, 407-14(Aug 1972).

The two-particle shell-model spectra of ^{18}O and ^{18}F are studied using effective interactions obtained from phase-shift-equivalent nucleon–nucleon potentials. The spectra depend significantly on the off-shell behavior of the potentials. (auth)

54539 ISOSPIN-FORBIDDEN AND ALLOWED ^{12}C(d,α)^{10}B CROSS SECTIONS. Smith, H. Vernon Jr. (Univ. of Wisconsin, Madison). Phys. Rev., C; 6: No. 2, 441-52(Aug 1972).

Extensive new data on the isospin-forbidden reaction ^{12}C(d,α_2)^{10}B (1.74) for 7.19 MeV ≤ E_d ≤ 13.99 MeV is reported. Also extensive data for the isospin-allowed reactions ^{12}C(d,$\alpha_{0,1,3}$)^{10}B is reported. All channels exhibit resonant behavior indicative of compound-nucleus formation. No evidence for appreciable direct or semidirect contribution to the α_2 cross sections was found. A partial-wave expansion of the α_2 data fixes J^π for a number of (isospin-mixed) ^{14}N compound-nuclear levels. The data do not support either Noble's proposed ^{6}Li mechanism or Weller's modification to Noble's proposal. (auth)

54540 ASYMMETRIC PROTON YIELDS FROM THE SEQUENTIAL REACTION ^{6}Li(^{3}He,αp)^{4}He. Thompson, D. T.; Tripard, G. E. (Washington State Univ., Pullman). Phys. Rev., C; 6: No. 2, 452-6(Aug 1972).

Measurements have been made of the asymmetric proton yields about the ^{5}Li recoil direction using the sequential reaction ^{6}Li(^{3}He,αp)^{4}He for both the ground and first excited states of ^{5}Li at a beam energy of 1.54 MeV. Measurements were made out of the reaction plane, and the results are in qualitative agreement with the predictions of a model proposed by Reimann, Martin, and Vogt. Distorted-wave Born-approximation stripping theory may also be capable of explaining the asymmetric results. (auth)

54541 SEMILEPTONIC WEAK INTERACTIONS WITH ^{12}C. O'Connell, J. S. (National Bureau of Standards, Washington, D. C.); Donnelly, T. W.; Walecka, J. D. Phys. Rev., C; 6: No. 3, 719-33(Sep 1972).

A unified analysis of semileptonic weak and electromagnetic interactions in nuclei is applied to the A = 12 system. The particle–hole model is used to describe the nuclear dynamics of ^{12}B, ^{12}C, and ^{12}N. Neutrino reaction cross sections are presented for comparison with future experiments. (9 figures, 3 tables) (auth)

54542 CORE-EXCITED 5^+ STATE IN ^{14}N. Noe, J. W.; Balamuth, D. P.; Zurmuehle, R. W. (Univ. of Pennsylvania, Philadelphia). Phys. Rev., C; 6: No. 3, 780-3(Sep 1972).

The proton and γ-ray decay of the T = 0 level at E_x = 10.81 MeV in ^{14}N was studied with the reactions ^{12}C(^{3}He,p)^{14}N(p')^{13}C$_{g.s}$ and ^{12}C(^{3}He,pγ)^{14}N at an incident ^{3}He energy of 14 MeV. The state was populated in an axially symmetric geometry in which the outgoing reaction protons were detected at 0° to the incident beam direction at the focus of a magnetic spectrometer. Analysis of the decay proton and γ-ray angular correlations leads to an assignment of $J^\pi = 5^+$ to the 10.81-MeV state. The γ-ray decay goes entirely to the $J^\pi = 3^+$, T = 0 state at E_x = 6.44 MeV; the fractional γ-ray branch of the 10.81-MeV state was measured as $\Gamma_\gamma/\Gamma_{total} = (4.1 \pm 0.8)\%$. (3 figures) (auth)

54543 SPECTROSCOPIC FACTORS FROM THE REACTIONS ^{12}C(d,n)^{13}N AND ^{12}C(d,p)^{13}C USING THE WBP MODEL. Pearson, C. A. (Univ. of Alabama, Birmingham); Covan, J. M.; Zissermann, D.; (and others). Nucl. Phys.; A191: No. 1, 1-18(1972).

Weakly bound projectile model calculations have been made for the reactions ^{12}C(d,p)^{13}C (ground state and 3.09 MeV state) and ^{12}C(d,n)^{13}N (ground state) to extract spectroscopic factors. Optical-potential parameters for the calculations have been obtained by fitting nucleon-nucleus elastic scattering from ^{12}C between 4 MeV and 20 MeV. The spectroscopic factors extracted are independent of the deuteron energy and overlap those from nuclear structure calculations. Uncertainties in these spectroscopic factors arising from ambiguities in the optical parameters are found to be ≲20%. (auth)

54544 ADIABATIC AND ANGULAR-MOMENTUM DEPENDENT POTENTIAL FOR ^{16}O–^{16}O SCATTERING. Perez, J. D. (Univ. of California, San Diego, La Jolla). Contracts AT(11-1)-GEN-10; AT(04-3)-113). Nucl. Phys.; A191: No. 1, 19-28(1972).

The statistical model of Brueckner et al. is used to calculate adiabatic potentials for elastic ^{16}O–^{16}O scattering. A rotational-energy term is added to the energy functional in order to include angular-momentum effects in the potential. This also allows consideration of the energy and density of yrast levels in ^{32}S. (auth)

54545 CONTINUUM SHELL MODEL CALCULATION FOR THE ^{15}N GIANT DIPOLE RESONANCE. Barrett, R. F. (Univ., Frankfurt am Main); Fraser, R. F.; Delsanto, P. P. Phys. Lett.; 40B: No. 3, 326-8(10 Jul 1972).

Results of a continuum shell-model calculation of the ^{15}N total photo-absorption cross section and (γ,p_0) cross section are presented and discussed. (auth)

54546 CROSS-SECTION FOR EJECTION OF DEUTERONS FROM ^{6}Li BY ELECTRONS. Jeremie, H. (Univ. of Montreal). Phys. Lett.; 40B: No. 3, 311-13(10 Jul 1972).

The cross section for ejection of deuterons from ^{6}Li is estimated in Born-approximation neglecting electric-quadrupole and magnetic scattering. The s- and p-state of ^{6}Li are described by simple and perturbed harmonic-oscillator wave functions respectively. Absorption is accounted for through a modified eikonal approximation and the results are normalized to elastic electron-deuteron scattering. (auth)

54547 DETERMINATION OF THE NEUTRON RADII OF SOME NUCLEI BY THE STUDY OF ALPHA ELASTIC SCATTERING AT 166 MeV. Brissaud, I.; Le Bornec, Y.; Tatischeff, B.; (nand others) (Institut de Physique Nucleaire, Orsay, France). Nucl. Phys.; A191: No. 1, 145-65(1972). (In French).

The angular distributions for 166 MeV α-particle elastic scattering have been measured and are presented. The differential cross sections obtained are analyzed with optical potentials whose real parts are derived from the convolution of nuclear-matter distributions with an effective α-nucleon interaction. This interaction is defined both from an analysis of α-scattering from N = Z light nuclei and from heavy nuclei whose matter distributions are supposedly well known. The imaginary parts of the optical potentials are either taken to be proportional to the real parts or to have a Woods–Saxon form. Using parameters for nuclear charge distributions derived from elastic electron scattering, radii of neutron matter distributions with errors varying between ±0.09 fm and ±0.16 fm are extracted for the following nuclei: ^{12}C, ^{24}Mg, ^{28}Si, ^{32}S, ^{40,44,48}Ca, ^{48}Ti, ^{56}Fe, ^{59}Co, ^{58,60,62}Ni, ^{68}Zn, ^{88}Sr, ^{89}Y, ^{90,94}Zr, ^{92}Mo, ^{116,118,120,124}Sn, ^{140}Ce and ^{208}Pb. The assumptions made in the present analysis and the resulting uncertainties are presented. Charge and neutron radii are compared in isotope and isotone families and to radii determinations from other sources. In particular, our results agree with those derived from proton-scattering analyses and with Hartree–Fock calculations but are not always in accord with the results obtained from Coulomb energy difference methods. (auth)

54548 STUDY OF THE REACTIONS ^{19}F(d,α), ^{19}F(d,p) AT E_d = 3 MeV AND EXCITED STATES OF ^{20}F. Laribi, S.; Beaumevieille, H.; Bendjaballah, N.; (and others) (Institut d'Etudes Nucleaires, Algiers). Nucl. Phys.; A191: No. 2, 368-84(1972). (In French).

The levels of ^{20}F below an excitation energy of 4.08 MeV have been studied by the ^{19}F(d,p)^{20}F reaction at E_d = 3 MeV with a differentially pumped gas target; absolute differential cross sections have been measured for 15 proton groups. A DWBA analysis indicates an l_n = 0 transfer for the 3.49, 3.53 and 4.08 MeV states and an l_n = 2 transfer for the 0.66, 2.04, 2.19, 2.97 and 3.59 MeV states. Spectroscopic factors for these levels have been obtained. The other angular distributions have been analyzed in terms of Hauser-Feshbach theory. A spin J = 4 is tentatively assigned to the 0.82 MeV state. (auth)

54549 ODD-PARITY THREE-PARTICLE, ONE-HOLE STRUCTURE IN ^{18}F VIA THE REACTION ^{15}N(^{6}Li,t)^{18}F. Lindgren, R. A.; Gutbrod, H. H.; Fulbright, H. W.; Markham, R. G. (Univ. of Rochester, N. Y.). Phys. Rev. Lett.; 29: No. 12, 798-801(18 Sep 1972).

Strong preferential excitation of the odd-parity levels in ^{18}F and sharply forward-peaked angular distributions were observed in the reaction ^{15}N(^{6}Li,t)^{18}F. These results imply that the reaction mechanism contains a direct component and that the odd-parity levels have large $(p)^{-1}(sd)^{3}$ configurations. (auth)

Nuclear Properties and Reactions, 20 ≤ A ≤ 38

Refer also to abstracts 54495, 54501, 54523, 54525, 54528, 54530, 54547, 54609, 54713, 54745, 54747, and 54960.

54550 (COO-535-671) RESOLUTION OF THE ^{20}Na BETA DECAY ANOMALY. Ingalls, Paul D. (Colorado Univ., Boulder. Dept. of Physics and Astrophysics). [nd]. 8p. Dep. NTIS.

An apparent hindrance of the superallowed Fermi decay ^{20}Na(β^+)^{20}Ne (10.277 MeV, T = 1) is explained. This anomaly is removed by estimates showing that the process ^{24}Mg(p,2n)^{23}Al(β^+)^{23}Mg (0.0) (of indistinguishable half-life and end point energy) interfered with previous measurements of ^{24}Mg(p,αn)^{20}Na(β^+)^{20}Ne (1.633 MeV). (auth)

54551 (COO-535-673) (p,t) AND (p,^{3}He) REACTIONS ON ^{27}Al AT E_p = 27 MeV. Graetzer, R.; Kraushaar, J. J.; Shephard, J. R. (Colorado Univ., Boulder. Dept. of Physics and Astrophysics). [nd]. 33p. Dep. NTIS.

Levels in ^{25}Al and ^{25}Mg were populated via the (p,t) and (p,^{3}He) reactions with 27-MeV protons on an ^{27}Al target. Angular distributions of emitted tritons and ^{3}He were measured simultaneously with a detector telescope. Zero-range DWBA calculations with simple shell model configurations for the two transferred nucleons provided satisfactory fits for several of the observed diffraction patterns. A sharp rise in cross section at forward angles was a good indication of the presence of L = 0 transfer even though transitions occurred with a mixture of L values. Compound nucleus calculations reproduced the smooth angular distribution shapes observed for higher excited levels but predicted cross sections consistently larger than those observed. For the first $^{1}/_{2}^{+}$ levels neither DWBA, compound nucleus, nor a direct two-step (p,d)(d,t) calculation were able to give a satisfactory description of the data. (auth)

54552 (FRNC-TH-227) STUDY OF THE ^{29}P NUCLEUS, DETERMINATION OF THE ANGULAR MOMENTA AND THE ELEMENTS OF THE GAMMA TRANSITION MATRIX. Byrski, Thaddee (Strasbourg Univ. (France)). 1971. 87p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

The ^{28}Si(p,γ) radiative capture reaction was used to study the first ten excited states of ^{29}P. The γ ray angular distributions and $\gamma-\gamma$ angular correlations were measured with a Ge–Li detector and a multicounter goniometer having seven NaI(Tl) detectors respectively. Doppler shift attenuation was used to determine the mean lives of the levels. The results obtained for incident protons with energies corresponding to eight resonances in the ^{28}Si(p,γ) reaction are given, these resonances occurring at 1649, 1383, 2981, 2287, 2634, 2880, 724, and 370 keV. The excitation energies, angular momenta, mean lives, level parities, branching ratios, and transition mixing coefficients were determined. The results obtained are discussed in terms of the shell model and the unified collective model. (France)

54553 SHELL-MODEL AND PROJECTED HARTREE–FOCK CALCULATIONS FOR ^{24}Mg, ^{28}Si, AND ^{32}S. Whitehead, R. R.; Watt, A. (Univ. of Glasgow). Phys. Lett.; 41B: No. 1, 7-10 (4 Sep 1972).

Shell-model and projected Hartree–Fock calculations of the spectra of ^{24}Mg, ^{28}Si, and ^{32}S are compared. The shell-model calculations were done in the untruncated $(sd)^n$ basis. The results show an increasing discrepancy between the two models from ^{24}Mg to ^{32}S. In particular, odd-J states in ^{28}Si found in the shell-model calculation are absent in the Hartree–Fock spectrum. (auth)

54554 EVIDENCE OF FURTHER ROTATIONAL STRUCTURE IN ^{26}Al. Price, H. G.; James, A. N.; Nolan, P. J. (and others) (Univ. of Liverpool). Phys. Rev., C; 6: No. 2, 494-7(Aug 1972).

A unique spin assignment of J = 4 is obtained for the level at 2068.7 keV in ^{26}Al which previously had a spin assignment of J = 3. The level was populated with the reaction ^{26}Mg(p,n)^{26}Al at a proton energy of 7.4 MeV and the angular distribution of the ground-state γ ray determined. The excitation energy and the E2 strengths indicate that this level and the level at 3404 keV with J = 5 are members of a K = 3 rotational band based on the 3^+ level at 417 keV. This proposed band, based on the parallel coupling configuration of a particle in Nilsson orbit 5 ($\Omega = 5/2$) with a particle in orbit 9 ($\Omega = 1/2$), is evidence of further rotational structure in ^{26}Al. (auth)

54555 YIELDS OF GAMMA RAYS EMITTED FOLLOWING CAPTURE OF NEGATIVE MUONS BY ^{28}Si AND ^{24}Mg. Miller, G. H.; Eckhause, M.; Martin, P.; Welsh, R. E. (Coll. of William and Mary, Williamsburg, Va.). Phys. Rev., C; 6: No. 2, 487-93 (Aug 1972).

The yields of specific final states excited in the capture of negative muons by ^{24}Mg and ^{28}Si were measured. The yields are compared with the cross sections for excitation of the analog states by 180° electron scattering and with the relative populations of levels produced by the decay of the giant-dipole-resonance states. (auth)

54556 POSSIBLE STATISTICAL-MODEL EXPLANATION FOR THE ^{26}Mg(p,t)^{24}Mg REACTION AT E_p = 26 MeV. Kemper, K. W.; Obst, A. W. (Florida State Univ., Tallahassee). Phys. Rev., C; 6: No. 2, 672-4(Aug 1972).

A simplified Hauser–Feshbach treatment of angular distributions of the ^{26}Mg(p,t)^{24}Mg reaction populating levels in ^{24}Mg up to 7.59-MeV excitation energy yields good agreement with the data for

several of the states above the 1.37-MeV 2^+ level. In particular, it is not necessary to invoke a direct two-step process to explain the magnitude and shape of the 3^+ level at 5.22 MeV excitation as suggested by Shepard, Kraushaar, and Baer. (auth)

54557 ELASTIC AND INELASTIC SCATTERING OF 12 MeV POLARIZED DEUTERONS BY ^{24}Mg. Brown, R. C.; Griffith, J. A. R.; Karban, O.; Roman, S.; Singh, J. (Univ. of Birmingham, Eng.). Nucl. Phys.; A191: No. 3, 663-72(1972).

The vector analyzing power was measured for 12.1-MeV deuterons scattered by ^{24}Mg. Angular distributions are presented for the ground and 1.37-MeV (2^+) states. The elastic scattering data could not be reproduced satisfactorily by spherical optical-model calculations. Both the DWBA and coupled-channels formalisms yielded an acceptable description of the inelastic scattering data for an average deuteron optical-model potential. Coupled-channels predictions of the elastic scattering vector analyzing power revealed strong dependence on the mode of excitation and the deformation parameter, while an addition of spin–orbit coupling had little effect on the calculated results. (4 figures, 1 table) (auth)

54558 ENHANCEMENT OF DIRECT PROCESSES IN HEAVY-ION REACTIONS AT HIGH ANGULAR MOMENTA. Puehlhofer, F.; Diamond, R. M. (Univ. of California, Berkeley). Nucl. Phys.; A191: No. 3, 561-76(1972).

Direct processes in reactions induced by ^{20}Ne on ^{27}Al were studied at incident energies from 4 to 10 MeV/nucleon by using in-beam γ-ray spectroscopy. In addition to products from compound-nucleus reactions, several nuclei between A = 18 and 28 were identified, and it is shown that most of them are produced in direct reactions. The excitation functions for direct reactions reveal a threshold at about 100 MeV beam energy, above which the cross sections increase by an order of magnitude. A similar increase was also found in measurements with an ^{16}O beam of 6 to 10 MeV/nucleon on the same target. This behavior is explained as a consequence of the restriction of fusion processes due to the limitation on the angular momentum of the compound nucleus and a corresponding increase of the number of partial waves available for direct reactions. (6 figures, 2 tables) (auth)

54559 STUDY OF THE LOW-LYING STATES IN ^{22}Mg. Rolfs, C. (Univ., Freiburg i. B. Univ. of Toronto); Kraemer, R.; Riess, F.; Kuhlmann, E. Nucl. Phys.; A191: No. 1, 209-24(1972).

New states have been found in ^{22}Mg at E_x = 5006 ± 2, 5317 ± 5 and 5837 ± 5 keV with spins of J = (≦4), (1, 2, 3) and (≧2), respectively, in coincidence and angular correlation studies of the reaction ^{20}Ne(^{3}He,nγ)^{22}Mg at E(^{3}He) = 4.3–11.5 MeV. For the known states below E_x = 6.3 MeV the following information has been obtained: E_x(keV) $\{J^\pi\}$ = 1247 (2^+), 3308 (4), 4402 (2), 5037 (1, 2), 5290 (2, 3, 4), 5464 (2, 3, 4), 5714 (1, 2) and 6928 (≦6). Branching and mixing ratios are reported. The mean-life of the 1247 keV state has been determined to be 1.0 ps with the use of the Doppler-shift attenuation method. (auth)

54560 STUDY OF ^{38}Ar LEVELS FORMED IN THE REACTION ^{34}S(α,γ)^{38}Ar. Chevallier, A.; Bozek, E.; Chevallier, J.; Pape, A.; Armbruster, R. (Centre de Recherches Nucleaires, Strasbourg). Nucl. Phys.; A191: No. 1, 201-8(1972). (In French).

Eighteen resonances were observed in the reaction ^{34}S(α,γ)^{38}Ar, in the range E_α = 3.6 – 4.8 MeV. Spins and parities have been determined by angular distribution and correlation measurements. The measured transition strengths and branching ratios are discussed. (auth)

54561 ANGULAR CORRELATION STUDIES FOR α-PARTICLE EXCITATION OF THE 1.78 MeV 2^+ STATE IN ^{28}Si. Ahlfeld, C. E.; Assousa, G. E.; Lasalle, R. A.; (and others) (Florida State Univ., Tallahassee). Nucl. Phys.; A191: No. 1, 137-44(1972).

The $\alpha-\gamma$ in-plane angular correlations of the reaction ^{28}Si(α, $\alpha_1\gamma$)^{28}Si have been measured at 10, 12, 14 and 18 MeV. Correlations were obtained for c.m. scattering angles from 20° to 170° in 3° steps. Extracted angular-correlation parameters show a strong energy dependence, with a more rapid variation of the correlation pattern as a function of scattering angle with bombarding energy increase. Detailed coupled-channels analyses of the 18 MeV data with coupling of the first three excited states to the ground state of ^{28}Si were performed and a prolate deformation β_R = 0.3 was deduced. (auth)

54562 ROTATIONAL BANDS OF ^{20}Ne. Vogt, E. (Oxford Univ.). Phys. Lett.; 40B: No. 3, 345-8(10 Jul 1972).

Using alpha-particle reduced-widths to distinguish alpha-cluster states from shell model states it is suggested that the lowest lying 8^+ level of ^{20}Ne belongs to the (8p–4h) rather than to the (4p) ground state band. Many new levels and level properties are predicted. (auth)

54563 ANGULAR DISTRIBUTION OF PHOTONEUTRONS FROM Al, Ti, Cu, Mo, W, Pb. Kovalev, V. P.; Kharin, V. P.; Gordeev, V. V.; Isaev, V. I. At. Energ. (USSR); 32: No. 6, 496-7(Jun 1972). (In Russian).

The angular distribution of photoneutrons was measured for the targets Al, Ti, Cu, Mo, W, and Pb, irradiating the latter with monoenergetic electrons with energies of 12 to 23 MeV. Threshold nuclear reactions of the types (n,p) or (n,α) were used as detectors with effective thresholds of 2.7, 4.5, and 8.1 MeV, respectively. The results are tabulated for angles ranging from 30 to 150°. (K.S.W.)

54564 POLARIZATION OF THE EMITTED NEUTRON IN MUON CAPTURE. Devanathan, V. (Univ. of Madras); Parthasarathy, R.; Ramachandran, G. Ann. Phys. (N. Y.); 72: No. 2, 428-44(Aug 1972).

The polarization of the emitted neutrons resulting from the capture of muons by complex nuclei is investigated, and it is pointed out that this study provides valuable information which is difficult to obtain from any other source. The effective muon-capture interaction Hamiltonian of Fujii and Primakoff is used as a starting point, and the sum and average over lepton spins are performed. The resulting nuclear matrix elements are evaluated and expressed in terms of density matrix ρ defined in the spin space of the emitted neutron. Then the longitudinal polarization of the emitted neutron is given by $Tr(\sigma \cdot \hat{n}\rho)/Tr\ \rho$, where $\hat{n}$ is the unit vector denoting the direction of emitted neutron. The expression for polarization involves the neutrino direction; and since a neutrino is not observed, an integration over its direction is performed. Numerical results are presented for ^{40}Ca, ^{32}S, and ^{28}Si. (18 figures, 34 references) (auth)

54565 INELASTIC SCATTERING CALCULATIONS WITH PROJECTED HARTREE-FOCK WAVE FUNCTIONS. II. COUPLED-CHANNEL TREATMENT. Ascuitto, Robert J. (Yale Univ., New Haven); Braley, Richard C.; Ford, William F. Nucl. Phys.; A192: No. 1, 97-124(1972).

A microscopic coupled-channel study of inelastic proton scattering from ^{20}Ne and ^{24}Mg is presented. At least the 0^+, 2^+, and 4^+ members of the ground state rotational band of each nucleus are included explicitly in the coupled equations, using nuclear wave functions obtained by projecting states of good angular momentum from deformed Hartree–Fock intrinsic states. The scattering results are compared with the distorted-wave Born approximation (DWBA) and experiment; truncation of the nuclear model space is also investigated. The results obtained with this microscopic model confirm conclusions drawn earlier based on the macroscopic model; in particular, the shapes and deformations predicted by the macroscopic model are well reproduced by the projected Hartree–Fock model, which is based purely on energy considerations. However, it is found that the magnitudes of cross sections to the higher levels are considerably smaller than experiment. A collective-model calculation, using optical potentials inferred from the intrinsic HF distributions, yields much better results. This suggests that microscopic descriptions of inelastic scattering are quite sensitive to details of the nucleon-nucleon interaction, which does not explicitly enter into the macroscopic description. (auth)

Nuclear Properties and Reactions, 39 ≤ A ≤ 58

Refer also to abstracts 54501, 54523, 54527, 54528, 54547, 54563, 54564, 54587, 54591, 54592, 54602, 54609, 54630, 54683, 54713, 54745, and 54960.

54566 (CONF-720901–(Bks.1 and 2), pp 1075–86) keV NEUTRON TOTAL CROSS SECTION MEASUREMENTS AT ORELA. Harvey, J. A. (Oak Ridge National Lab., Tenn.). 1972.

From Meeting on new developments in reactor physics and shielding calculations; Kiamesha Lake, NY. (12 Sep 1972).

Neutron total cross sections are measured at ORELA using samples as small as a few square millimeters, flight paths from 18 to 200 meters, with energy resolutions ($\Delta E/E$) from 1/300 for measurements below ~10 keV to ~1/2500 up to 200 keV and $\sqrt{E(\text{in MeV})}/1000$ above 1 MeV. A new efficient neutron detector using NE 110 has been developed for keV measurements whose efficiency is ~30% for 10 keV neutrons rising to 90% for 50 keV neutrons. Transmission measurements using iron-filtered neutron beams have been made upon thick samples of iron 4'', 6'', 12'' and 20'' to obtain accurate values of the cross-section minima. Enriched ^{54}Fe and ^{57}Fe samples have been measured to determine their contributions to the windows in natural iron. (auth)

54567 (INR–1407) CROSS SECTIONS FOR THE PROTON INDUCED REACTIONS ON THE ^{43}Ca, ^{44}Ca, AND ^{48}Ca ISOTOPES

IN THE PROTONS ENERGY RANGE 1 TO 2 MeV. Grochulski, Witold; Marcinkowski, Andrzej; Wilhelmi, Zdzislaw (Institute of Nuclear Research, Warsaw (Poland)). 1972. 16p. Dep. NTIS (U. S. Sales Only).

Proton-induced reaction cross sections on calcium isotopes ^{42}Ca, ^{43}Ca and ^{48}Ca, as well as the isomeric cross-section ratios in the reaction ^{43}Ca(p,γ)^{44}Sc, measured by the activation method, in the proton energy range 1–2 MeV, are given. (auth)

54568 (LBL–776) KAONIC ATOM TRANSITION COUPLED TO NUCLEAR LEVEL. Godfrey, Gary L.; Wiegand, Clyde E. (California Univ., Berkeley. Lawrence Berkeley Lab.). Jun 1972. Contract W-7405-eng-48. 9p. Dep. NTIS.

A possible resonance coupling has been found between the first excited state of ^{55}Mn nuclei and transitions from Bohr orbits n = 9 to n = 6 in kaonic Mn atoms. (auth)

54569 (ORNL–4798) GAMMA-RAY PRODUCTION DUE TO NEUTRON INTERACTIONS WITH IRON FOR INCIDENT NEUTRON ENERGIES BETWEEN 0.8 AND 20 MeV: TABULATED DIFFERENTIAL CROSS SECTIONS. Dickens, J. K.; Morgan, G. L.; Perey, F. G. (Oak Ridge National Lab., Tenn.). Aug 1972. Contract W-7405-eng-26. 67p. Dep. NTIS.

Numerical values of differential cross sections for gamma rays produced by neutron reactions with iron have been obtained for neutron energies between 0.8 and 20 MeV. The data are primarily for $\theta_\gamma = 125°$ with supporting data at $\theta_\gamma = 35$, 75 and 90°. These data consist of (a) discrete-line values of $d\sigma/d\omega$ for 45 observed transitions due to neutron interactions with natural iron; and (b) neutron gamma-ray production group cross section values of $d^2\sigma/d\omega\, dE$ for $0.7 \geq E_\gamma \leq 10.5$ MeV, with gamma-ray group sizes ranging from 20 keV for $E_\gamma \leq 1$ MeV to 160 keV for $E_\gamma \leq 9$ MeV. The $d\sigma/d\omega$ values were obtained for $4.85 \leq E_n \leq 9.0$ MeV using a Ge(Li) spectrometer. Additional discrete-line $d\sigma/d\omega$ values for $4.85 \leq E_n \leq 6.45$ MeV at $\theta_\gamma = 125°$ have been tabulated for 66 observed transitions due to neutron interactions with an iron sample enriched in the isotope ^{54}Fe. The $d^2\sigma/d\omega\, dE$ values were obtained for $0.8 \leq E_n \leq 20$ MeV using a NaI spectrometer. (auth)

54570 SHELL-MODEL STUDY OF ^{56}Ni, ^{58}Ni, ^{54}Fe, AND ^{56}Fe. Oberlechner, G.; Richert, J. (Centre de Recherches Nucleaires, Strasbourg). Nucl. Phys.; A191: No. 3, 577-95(1972).

Shell-model calculations of ^{56}Ni, ^{58}Ni, ^{54}Fe and ^{56}Fe are presented. States are assumed to belong to configurations involving no excitation and two-particle excitations from the $1f_{\frac{7}{2}}$ shell. A limited number of core-excited states corresponding to four-particle excitations are also taken into account in the cases of ^{56}Ni and ^{58}Ni. The effective two-body interaction in the (1f,2p) shell is deduced from a nonlocal potential which reproduces the nucleon-nucleon scattering data. Calculated energy spectra and transition rates are not in good agreement with experiment. This is certainly related to the truncation of the basis. Some improvements are obtained when single-particle energy spacings are allowed to vary. (auth)

54571 OPTICAL-MODEL ANALYSIS OF ELASTIC SCATTERING OF 53.4 MeV HELIONS FROM ^{56}Fe. Marchese, C. J. (King's Coll., London); Griffiths, R. J.; Clarke, N. M.; (and others). Nucl. Phys.; A191: No. 3, 627-40(1972).

Elastic helion scattering from ^{56}Fe at 53.4 MeV was measured over the angular range 12° to 150°. Using the regular optical model, real-potential ambiguities, the shape of the imaginary term and the need for a spin-orbit term were explored. Coupled-channels (SCA) calculations based on the ground state and principal 2^+ and 3^- states indicate that such coupling effects are not as dominant as the inclusion of a spin-orbit potential in the regular optical model. Previously reported helion scattering from ^{59}Co and ^{60}Ni at 50.1 MeV has been included in an average parameter analysis to generalize the improvements in the helion optical-model parameterization in this energy region. (auth)

54572 ELASTIC SCATTERING OF VECTOR POLARIZED DEUTERONS FROM ^{48}Ti, ^{49}Ti, ^{50}Ti, ^{51}V, ^{52}Cr. Heil, G.; Klier, G.; Wilsch, H. (Univ., Erlangen, Ger.). Nucl. Phys.; A191: No. 3, 489-96(1972).

The elastic scattering of vector polarized deuterons with a mid-target energy of $E_d = 11.9$ MeV from ^{48}Ti, ^{49}Ti, ^{50}Ti, ^{51}V and ^{52}Cr was measured and analyzed in terms of a standard optical potential containing a spin-orbit term. The analysis showed that all nuclei under investigation have very similar parameters. The depth, range and diffuseness of the Thomas-type spin-orbit potential tended to be small, typical values being $V_{s.o.} = 5.06$ MeV, $r_{s.o.} = 0.70$ fm, $a_{s.o.} = 0.40$ fm (^{50}Ti). A comparison of the results for target nuclei with spin (^{49}Ti, ^{51}V) to those for the neighboring spin-zero nuclei yielded no hint for a target spin-dependent interaction. (auth)

54573 $(1f)^2_{\frac{7}{2}}$ MULTIPLET IN ^{42}Ca. Ellegaard, C. (Univ. of Copenhagen); Lien, J. R.; Nathan, O.; (and others). Phys. Lett.; 40B: No. 6, 641-4(21 Aug 1972).

The states of ^{42}Ca below 3.2 MeV excitation were studied by the ^{41}Ca(d,p)^{42}Ca reaction at 12 MeV bombarding energy. The experimental spectroscopic factors are compared to predictions based on Gerace and Green's coexistence model. (auth)

54574 g-FACTOR OF THE 3/2$^-$ 153-keV STATE IN ^{49}V. Vingiani, G. B. (Univ., Padua. INFN, Padua); Rossi-Alvarez, C.; Buscemi, A.; Brandolini, F.; Cervellera, F. Phys. Lett.; 40B: No. 6, 638-40(21 Aug 1972).

The g factor of the $\frac{3}{2}^-$ state at 153 keV in ^{49}V was measured with the ^{48}Ti(p,γ)^{49}V reaction and the differential spin-precession method. The g value and the remeasured mean life are $g = +1.58 \pm 0.08$ and $\tau = 28.7 \pm 0.5$ ns. The result is compared with some theoretical predictions. (auth)

54575 LIFETIME OF THE 3.74-MeV (3$^-$) STATE OF ^{40}Ca. Tape, J. W. (Rutgers–The State Univ., New Brunswick, N. J.); Benczer-Koller, N.; Hensler, R.; MacDonald, J. R. Phys. Lett.; 40B: No. 6, 635-7(21 Aug 1972).

The mean life of the 3.74-MeV (3$^-$) excited state of ^{40}Ca was directly measured by a particle–gamma delayed coincidence technique. A mean life $\tau = 59 \pm 5$ ps was obtained, corresponding to a transition strength B(E3) = 31 ± 3 W.u. (auth)

54576 CALCULATION OF THE STATES IN ^{53}Fe. Shikata, Y. (Aoyama Gakuin Univ, Tokyo). Phys. Lett.; 40B: No. 6, 611-2 (21 Aug 1972).

The states in ^{53}Fe are calculated in an extended space which includes a few 1p–4h states. Calculated energy levels and spectroscopic factors qualitatively agree with experiment. (auth)

54577 GROUND STATE OF ^{40}Ca. Hubbard, L. B. (Oak Ridge National Lab., Tenn. Furman Univ., Greenville, S. C.); McGrory, J. B.; Jolly, H. P. Phys. Rev., C; 6: No. 2, 532-6 (Aug 1972).

The ground-state wave function for ^{40}Ca has been calculated on the basis of 176 configurations containing all $2\hbar\omega$ excitations in addition to the doubly-closed-shell configuration. The ground state is found to be in the closed-shell configuration about 70% of the time. The rest of the intensity is highly fractionated over many of the basis configurations. The ground state is found to lie about 10 MeV lower in energy than the pure closed-shell configuration. (auth)

54578 INVESTIGATIONS OF SPIN ASSIGNMENTS IN ^{41}Ca, ^{53}Cr, AND ^{55}Fe. McIntyre, L. C.; Donahue, D. J. (Univ. of Arizona, Tucson). Phys. Rev., C; 6: No. 2, 568-71(Aug 1972).

The angular correlations of γ rays from (d,pγ) reactions with 3-MeV deuterons to states in ^{41}Ca, ^{53}Cr, and ^{55}Fe have been measured utilizing a collinear geometry and a Ge(Li) γ-ray detector. This study was undertaken in an attempt to resolve conflicts in spin assignments between vector-analyzing-power measurements and other measurements. Results indicate $J = \frac{1}{2}$ for the 3618-keV level in ^{53}Cr and the 3788-keV level in ^{55}Fe in agreement with the vector-analyzing-power measurements. The conflict is not resolved in the case of the 3614-keV level in ^{41}Ca. There is a strong possibility that there are two unresolved levels in this region, one with $J = \frac{1}{2}$ and the other with $J = \frac{3}{2}$. (auth)

54579 REACTION-MECHANISM STUDY IN THE 1f–2p SHELL OF (^{16}O,^{12}C) FOUR-NUCLEON-TRANSFER REACTION. Bonche, P. (Cen, Saclay, France); Giraud, B.; Cunsolo, A.; (and others). Phys. Rev., C; 6: No. 2, 577-86(Aug 1972).

The (^{16}O,^{12}C) four-nucleon-transfer reaction has been performed on a ^{54}Fe target using the 46-MeV ^{16}O beam of the FN tandem Van de Graaff at Saclay. The study of the reaction ^{54}Fe(^{16}O,^{12}C)^{58}Ni shows that the four-nucleon transfer occurs via a direct surface reaction, well described by the quasielastic process formalism due to Frahn and Venter, which is based on the diffractional model. The transfer-reaction cross sections are peaked at the grazing angle where the elastic scattering begins to deviate from the pure Rutherford law. A distorted-wave Born-approximation investigation of nuclear properties of levels reached by (^{16}O,^{12}C) four-nucleon transfer has been performed using the SETILL code based on the generator-coordinate framework. The Q-value dependence of the cross section, as well as the configuration mixing effects, has been estimated. The cases of other 1f–2p-shell nuclei have been also investigated. (auth)

54580 ENERGY DEPENDENCE OF THE ^{3}He OPTICAL POTENTIAL. Marchese, C. J.; Clarke, N. M.; Griffiths, R. J. (King's Coll., London). Phys. Rev. Lett.; 29: No. 10, 660-2(4 Sep 1972).

A multi-data-set optical-model search code was used to produce a set of mean geometry parameters for ^{3}He nuclei incident on medium-weight nuclei. The energy dependence of the volume integrals of the real and imaginary potentials was obtained for this geometry. (auth)

54581 MAGNETIC MOMENT OF THE 1.409-MeV 2^+ STATE OF ^{54}Fe. Hubler, G. K. (Rutgers-The State Univ., New Brunswick, N. J.); Kugel, H. W.; Murnick, D. E. Phys. Rev. Lett.; 29: No. 10, 662-5(4 Sep 1972).

The g factor of the first excited 2^+ state of ^{54}Fe was measured to be $g = 1.43 \pm 0.28$. The $0 \rightarrow 2 \rightarrow 0$ (^{16}O,γ) angular correlation through the 1.4-ps mean-life state was precessed using the transient magnetic field effective in iron on Coulomb-excited and recoiled ^{54}Fe. This result is in agreement with a quite pure $(f_{\frac{7}{2}})^{-2}$ shell-model configuration for the state. (auth)

54582 INELASTIC PROTON SCATTERING FROM ^{48}Ca. Maggiore, Carl Jerome. East Lansing, Mich.; Michigan State Univ. (1972). 224p. University Microfilms Order No. 72-22,252.

Thesis.

Inelastic proton scattering from the nucleus ^{48}Ca has been performed at 25.11, 29.83, 35.00, and 40.21 MeV, using the proton beam from the MSU sector-focused cyclotron. Cross sections were taken every five degrees from 13° to 100° with Ge(Li) counters. The over-all resolution obtained was less than 30 keV at all energies. The elastic scattering from ^{48}Ca was compared with the elastic scattering from ^{40}Ca using the optical model. It was found that the relative distributions are in agreement with the predictions of the $A^{\frac{1}{3}}$ law. The inelastic scattering revealed several previously unreported excited states in ^{48}Ca. Angular momentum transfers for most of the states were obtained by comparison of the shapes of the angular distributions to those of known L. Where possible, spin assignments are inferred on the basis of this and other data. The experimental angular distributions are compared with calculated distributions using the collective model distorted wave Born approximation. The nuclear deformations obtained are used to calculate the vibrational model parameters and the reduced transition probabilities. The results are compared with previous inelastic alpha scattering experiments and inelastic electron scattering results. The energy dependence of the results and the sensitivity of the deformations to the optical model parameters were studied. (Diss. Abstr. Int., B)

54583 STUDY OF EVEN CALCIUM AND NICKEL ISOTOPES WITH SELF-CONSISTENT APPROXIMATIONS. Chandra, Harish; Rustgi, M. L. (State Univ. of New York, Buffalo). Phys. Rev., C; 6: No. 3, 907-14(Sep 1972).

Self-consistent Hartree–Fock, Hartree–Fock–Bogolyubov (HFB), and spherical BCS calculations for even calcium and nickel isotopes are carried out through the use of the central Yukawa interaction and renormalized matrix elements for the Hamada–Johnston and Tabakin potentials. The existence of spherical ^{40}Ca and ^{56}Ni cores is assumed, and the calcium and nickel isotopes are treated within the framework of single-closed-shell structure. It is found that for a given isotope and interaction the HFB and spherical BCS approximations always correspond to the same actual minimum energy solution. This feature is observed for all the isotopes and interactions considered, although the quasiparticle energies and the occupation numbers are found to differ. For Ca isotopes and the BCS results are also compared with the shell-model calculations of McGrory, Wildenthal, and Halbert, and are found to approximate the ground-state properties of all the even isotopes rather well. (2 figures, 2 tables) (auth)

54584 TWO-NUCLEON PICK-UP FROM SPIN-½ TARGETS. I. ^{57}Fe. Peterson, R. J.; Rudolph, H. (Univ. of Colorado, Boulder.). Nucl. Phys.; A191: No. 1, 47-64(1972).

Differential cross sections were measured for the (p,t) and (p,τ) reactions on ^{57}Fe at a proton energy of 27 MeV, and for the (d,α) reaction at 16.0 MeV. Several spin-parity assignments for ^{55}Fe and ^{55}Mn are suggested, and comparisons to DWBA calculations allow the identification of those states with a strong two-hole parentage. Attempts to find simple relations between these results and the yields from two-nucleon pick-up reactions on nearby doubly even targets were not successful. (auth)

54585 RESONANCE ACTIVATION INTEGRALS OF SOME NUCLIDES OF INTEREST IN NEUTRON ACTIVATION ANALYSIS. Steinnes, E. (Institutt for Atomenergi, Kjeller, Norway). J. Inorg. Nucl. Chem.; 34: No. 9, 2699-2703(Sep 1972).

The following previously-unreported resonance activation integrals I_0 were determined: ^{46}Ca, 0.32 ± 0.12b; ^{84}Sr, 10.6 ± 1.1b; ^{130}Ba, 270 ± 70b; ^{152}Gd, 3000 ± 300b; ^{158}Gd, 84 ± 20b. In addition, I_0 values for 21 nuclides were redetermined. The determinations were based on cadmium ratio measurements and on known values for the thermal neutron activation cross-sections. Small samples of ^{197}Au (σ_0 = 98.8b, I_0 = 1550b) were used as flux monitors. The thermal neutron activation cross-section for ^{152}Gd was found to be 1100 ± 100b. (auth) (UK)

54586 (^{6}Li,d) ON ^{58}Ni AND ^{64}Ni. Gutbrod, Hans H.; Markham, Roger G. (Univ. of Rochester, N. Y.). Phys. Rev. Lett.; 29: No. 12, 808-11(18 Sep 1972).

The (^{6}Li,d) reaction was performed on ^{58}Ni and ^{64}Ni at 38 MeV. For ^{58}Ni, angular distributions were obtained and compared with distorted-wave Born-approximation calculations. One spectrum was taken for ^{64}Ni. A reduction in cross section is observed and compared with the results of (^{16}O, ^{12}C), (p,t), and (^{3}He,n) experiments. (auth)

Nuclear Properties and Reactions, 59 ≤ A ≤ 89

Refer also to abstracts 54547, 54563, 54580, 54585, 54586, 54609, 54630, 54656, 54667, and 54881.

54587 (FRNC-TH-240) EXPERIMENTAL STUDY OF EXCITED STATES OF ^{58}Ni, ^{60}Ni, ^{62}Ni, AND ^{64}Ni. Beuzit, Pierre (Paris Univ., Orsay (France)). 1971. 114p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

The structure of even Ni nuclei was studied by the following experiments: (p,p'γ) experiments with ^{58}Ni, ^{60}Ni, ^{62}Ni and ^{64}Ni nuclei; (p,p') and (d,p) experiments with ^{62}Ni and ^{64}Ni nuclei. Twelve MeV proton and deuteron beams were used. The γ de-excitation scheme together with the associated branching ratios was established for the levels. The spins and parities were determined. Considerable analogy exists between the excited states of the different isotopes studied. The energies, wave functions, and transition probabilities of the levels of the quasi-particle model were calculated in the framework of the RPA approximation using the codes developed by the theoreticians at Saclay. These calculations, which are confirmed by the results of the ^{59}Co(^{3}He, dγ) reaction, demonstrate the important role played by the core protons in the collective level configurations and the considerable participation of the proton–neutron interaction. This fact suggests the coexistence of pair configurations and more complex 2, 4, and 6 quasi-particle configurations in these nuclei. (France)

54588 CONSISTENT COUPLED-CHANNEL BORN APPROXIMATION ANALYSIS OF ^{88}Sr(d,np)^{88}Sr AND ^{88}Sr(d,p)^{89}Sr. Hoffmann, G. W.; Coker, W. R.; Zaidi, S. A. A.; Elliott, D. O. Jr. (Univ. of Texas, Austin). Phys. Lett.; 41B: No. 1, 47-9(4 Sep 1972).

Differential and total cross sections for ^{88}Sr(d,n$\tilde{p}$)^{88}Sr were obtained and compared with the results of coupled-channel Born approximation calculations, which also are in agreement with earlier data for ^{88}Sr(d,p)^{89}Sr($d_{\frac{5}{2}}$ g.s.) excitation functions at 170°. (auth)

54589 ISOMER RATIOS IN (n,γ) REACTIONS AT 25 keV. Rao, A. Lakshmana; Rama, Rao J. (Andhra Univ., Waltair, India). Phys. Rev., C; 6: No. 2, 572-7(Aug 1972).

Isomeric cross-section ratios are measured for eight (n,γ) reactions on the target nuclei ^{74}Ge, ^{79}Br, ^{80}Se, ^{85}Rb, ^{103}Rh, ^{121}Sb, ^{151}Eu, and ^{164}Dy at an incident neutron energy of 25 ± 5 keV. These ratios are theoretically calculated using two models, viz., (1) the Huizenga–Vandenbosch model and (2) the γ-ray cascade model of Ponitz. A comparison of the experimental and theoretical ratios shows that the experimental values agree better with the predictions of the Ponitz model than with those of the Huizenga–Vandenbosch model. It is also observed that, on the basis of Ponitz model, the amounts of quadrupole admixtures required to reproduce experimental isomer ratios are in the range 1–25%. The present estimates of the quadrupole admixtures are in line with previous observations made at thermal energies. (auth)

54590 ELASTIC AND INELASTIC WIDTHS OF ANALOGUE STATES IN ^{65}Cu. Ramavataram, K.; Yang, C. S.; Mercier, G. F.; (and others) (Univ. Laval, Quebec). Nucl. Phys.; A191: No. 1, 88-96(1972).

Elastic and inelastic excitation of IAR were studied using protons of 3 to 5 MeV energy incident on ^{64}Ni. The spins of some of the analog states as well as their elastic and inelastic widths are obtained from the experimental results. Spectroscopic factors were deduced from the resonance parameters and calculated single-particle widths and are compared with the shell-model predictions. (auth)

54591 NUCLEAR REACTIONS OF NICKEL WITH PROTONS UP TO 56 MeV. Tanaka, S.; Furukawa, M.; Chiba, M. (Tokyo Univ.). J. Inorg. Nucl. Chem.; 34: No. 8, 2419-26(Aug 1972).

Excitation functions were measured for a number of nuclear reactions of nickel isotopes with 5 to 56 MeV protons. The following peak cross sections were determined: ^{58}Ni-(p,pn)-260 mb, (p,p2n)-21 mb, (p,2p)-540 mb, (p,2pn)-350 mb, (p,α)-40 mb, (p,2p2n)-63 mb, (p,αpn)-38 mb; ^{60}Ni-(p,n)-320 mb, (p,2pn)-180 mb, (p,2p2n)-200 mb, (p,αn)-72 mb, (p,α2n)-14 mb; ^{61}Ni-(p,n)-480 mb; ^{62}Ni-(p,n)-480 mb, ^{64}Ni(p,n)-670 mb. Cross sections for the following reactions were determined up to E_p = 56 MeV: ^{58}Ni-(p,

αp2n), (p,α2pn); ^{60}Ni-(p,p3n), (p,α), (p,2p3n), (p,α2pn); ^{61}Ni-(p,α). Measurements were also made for the cross sections of ^{60}Co formation from natural nickel. (auth)

54592 ^{57}Fe(t,p)^{59}Fe AND ^{58}Fe(d,p)^{59}Fe REACTIONS. McLean, K. C.; Dalgliesh, S. M.; Ipson, S. S.; Brown, G. (Univ. of Bradford, Eng.). Nucl. Phys.; A191: No. 2, 417-37(1972).

The level structure of ^{59}Fe has been investigated using the (d,p) and (t,p) reactions at incident energies of 10 MeV and 12 MeV respectively. Unambiguous spin assignments are made for many levels from a comparison of the angular-momentum transfer of the two reactions. It is shown that the experimental data provide strong support for the existence in ^{59}Fe of a rotational band structure. (auth)

54593 GAMMA TRANSITIONS IN ^{60}Ni FOLLOWING THE β^+ DECAY OF ^{60}Co. II. van Patter, D. M. (Franklin Inst., Swarthmore, Pa.); Rauch, F. Nucl. Phys.; A191: No. 2, 245-56(1972).

Gamma-ray spectra following the decay of ^{60}Cu have been re-examined on the basis of recent new information concerning the properties of ^{60}Ni levels. Additional direct β^+ branches to the 3871.4(2^+), 3925.6(3^+) and 4535.9 keV states of ^{60}Ni have been identified with log ft values of 6.9, 6.4 and 6.1 respectively. Log ft values have been revised for some previously established branches, and limits for direct population of several other energetically available states are presented. It is noted that the 3194.1 keV 1_1^+ and 3735.5 keV 1_2^+ states prefer to decay much more strongly to the 0_2^+ rather than the 0_1^+ state, while the 4020.4 keV 1_3^+ state shows no such preference. (auth)

54594 ANGULAR CORRELATIONS OF γ-RAYS FROM COULOMB EXCITED ^{63,65}Cu. Robinson, R. L.; Grabowski, Z. W. (Oak Ridge National Lab., Tenn.). Nucl. Phys.; A191: No. 2, 225-32(1972).

The multipole admixtures of the transitions between the low-lying $^7/_2^-$ and $^5/_2^-$ states of ^{63,65}Cu have been obtained from angular distributions and γ-γ angular correlations. The states were excited via Coulomb excitation effected with α-particles. The admixture δ for the 365.3 keV γ-ray in ^{63}Cu is -0.105 ± 0.025. For the 366.7 keV γ-ray in ^{65}Cu it is -0.16 ± 0.06. Values extracted for the B(E2) and B(M1) transition rates with these admixtures are: $(2.8^{+0.5}_{-0.5}) \times 10^{-50} e^2 \cdot cm^4$ and 0.24 ± 0.04 (eh/2Mc)^2 for the 365 keV γ-ray and $9.2^{+3.8}_{-3.8}$ and 0.34 ± 0.08 for the 367 keV γ-ray. (auth)

54595 HALF-LIFE OF ^{80g}Br. Collins, K. E.; Collins, C. H.; Kapauan, P. A.; (and others) (Philippine Atomic Research Center, Quezon City). J. Inorg. Nucl. Chem.; 34: No. 9, 2971-3(Sep 1972).

The half-life of ^{80g}Br was redetermined using samples purified by utilizing the chemical effects of the ^{80m}Br(I.T.)^{80g}Br transformation to minimize contamination. In one procedure the nuclear transformation was used to prepare organically-combined ^{80g}Br from an inorganic parent containing ^{80g}Br, with the half-life being directly related to the decay of the organically-combined ^{80g}Br, while in the second procedure, the half-life was determined from the grow-in of ^{80g}Br as a consequence of the ^{80m}Br(I.T.)^{80g}Br transformation in an ^{80m}Br-labeled organic parent, CBr_4, freed of nearly all of the previous ^{80g}Br. Values of 17.68 ± 0.02 min, and 17.7 ± 0.2 min were obtained, respectively. (auth) (UK)

Nuclear Properties and Reactions, 90 ≤ A ≤ 149

Refer also to abstracts 54547, 54563, 54585, 54589, 54643, 54657, 54667, and 55060.

54596 (CEA-R-4286) EXCITED LEVELS OF EVEN-A ISOTOPES (RUTHENIUM AND PALLADIUM). Pinston, Jean-Alain (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). May 1972. 117p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Universite Scientifique et Medicale de Grenoble, France.

Nuclear spectroscopy has been used to investigate β decay excited levels in the following nuclei: ^{102} and ^{104}Ru and ^{108} and ^{110}Pd. β and γ spectra, coincidences measurements, levels schemes with spins and parity are given for each of the following decays: ^{102}Tc (two isomers) → ^{102}Ru; ^{104}Tc → ^{104}Ru; ^{108}Rh (two isomers) → ^{108}Pd and ^{110}Rh (two isomers) → ^{110}Pd. These nuclei have been obtained by (n,p) reaction or ^{235}U(n,f). Two new isomeric states (6 min and 28 s half-life) have been evidenced in ^{108}Rh and ^{110}Rh respectively. The first excited levels of the even–even nuclei are represented in terms of DAVYDOV collective models. A new theoretical attempt is described: the DAVYDOV model is connected to the "variable inertia moment" model. This model, a pure phenomenological picture, can be reproduced by introducing a special β-vibration potential energy into the DAVYDOV model. (auth)

54597 (CONF-720901–(Bks.1 and 2), pp 1107-14) IRON-FILTERED NEUTRON BEAMS: A NEW APPROACH TO PRECISION TIME-OF-FLIGHT CROSS SECTION MEASUREMENTS. Block, R. C.; Kaushal, N. N.; Hockenbury, R. W. (Rensselaer Polytechnic Inst., Troy, N. Y.). 1972.

From Meeting on new developments in reactor physics and shielding calculations; Kiamesha Lake, NY. (12 Sep 1972).

By placing thick iron filters in a white-source time-of-flight neutron beam, it is possible to obtain a low-background transmitted beam of bands of neutrons with energies corresponding to the cross section minima in the filter. Capture cross section measurements were carried out upon In, Ta, Au, and ^{238}U near the 24.3 keV energy band, and the integrated capture cross sections are determined to be in the ratio $\tilde{\sigma}$(In) : $\tilde{\sigma}$(Ta) : $\tilde{\sigma}$(Au) : $\tilde{\sigma}$(^{238}U) = (0.88) : (0.96) : (0.67) : (0.47). This technique is intrinsically capable of an accuracy in the cross section of 2 to 3 percent. (auth)

54598 (FRNC-TH-242) STUDY OF THE DIPOLAR GIANT RESONANCE BY MEASURING PHOTONEUTRON CROSS SECTIONS. Carlos, Pierre (Paris Univ., Orsay (France)). 1972. 245p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

The dipolar giant resonance was studied for intermediate-mass nuclei and heavy nuclei, by measuring the photonuclear cross sections sigma (γ,xn) (x = 1,2,3,4). The theoretical results, obtained for photonuclear reactions, which are valid for all nuclear models are examined. The basic calculations relating to the collective models of the giant resonance are presented. The results obtained are discussed for the following nuclei: Sn, ^{127}I, Ba, ^{139}La, Ce, ^{141}Pr, Sm, ^{159}Tb, ^{165}Ho, Er, Lu, Ta and ^{197}Au and on the Nd isotopes with the masses 142, 143, 144, 145, 146, 148, 150. The theory of the particle-hole model of the giant resonance is presented. The results obtained for ^{208}Pb, Rb, Sr, ^{89}Y, ^{90}Zr and ^{93}Nb are given and discussed; emphasis is put on the isobaric splitting of the dipolar states. The results relating to the various dipolar sum rules are briefly illustrated. (France)

54599 (IAE–2116) NEUTRON RESONANCES ^{112}Cd. Shchepkin, Yu. G.; Muradyan, G. V.; Adamchuk, Yu. V. (Institut Atomnoi Energii, Moscow (USSR)). 1971. 24p. (In Russian). Dep. NTIS (U. S. Sales Only).

The neutron resonances of ^{112}Cd were investigated: Spins were assigned to 23 levels out of 29 observed levels. Values of S_0 and S_1 are strength functions determined after allowing for the probability of identification: $S_0 = (0.72^{+0.40}_{-0.40}) \times 10^{-4}$, and $S_1 = (3.9^{+1.7}_{-1.7}) \times 10^{-4}$. For 12 strong levels values of the radiation width $\Gamma\gamma$ were found with an accuracy of ~15%. The average value of $\Gamma\gamma = 80 \pm 4$ MeV was compared with calculated results from various models. (tr-auth)

54600 (INS–J–130) QUASI-BANDS IN EVEN–EVEN NUCLEI. Sakai, Mitsuo (Tokyo Univ. (Japan). Inst. for Nuclear Study). 15 Sep 1971. 41p. NTIS (U. S. Sales Only).

The quasi-band theory of nuclear structure is presented. The general aspect of the quasi-band structure is illustrated schematically. The author and his collaborators studied experimentally nuclei in which the quasi-band structure was seen. The study revealed that there was some band-like structure in so-called soft transitional regions. Extensive experimentation was performed at Institute for Nuclear Study, University of Tokyo, with in-beam spectroscopy. Proton beams accelerated up to 40 MeV were used to produce ^{126}Xe, ^{124}Xe, ^{132}Ba, ^{130}Ba, ^{136}Ce and ^{138}Nd. Emitted gamma-rays were observed with a Ge(Li) detector. Properties of the levels from which the gamma-rays were emitted were assigned from excitation curves. Properties of the quasi-gamma band were discussed in terms of B(E2) values, which were compared with theoretical predictions by Davydov and Filipov. The location of quasi γ_3 state was discussed in connection with the model of Davydov and Chaban. Log-ft values from parent nuclei to quasi-beta (β_0) and quasi-gamma (γ_2) states were investigated, and the results supported the band structure in the soft and transitional nuclei. The author said that the quasi-band concept is useful. (Japan)

54601 (IS–T–534) STUDY OF ELECTRON EMISSIONS OF SOME MASS SEPARATED FISSION PRODUCT ACTIVITIES. Adams, James Paul (Ames Lab., Iowa). Aug 1972. Contract W-7405-eng-82. 100p. Dep. NTIS.

Thesis.

The beta decay energies for seven short-lived radioactive nuclei produced at the TRISTAN experimental facility were measured using a plastic scintillator and a Ge(Li) detector in a beta-gamma arrangement. The beta decay energies were compared with pre-

vious measurements and systematics predictions and were used to predict the beta decay energies for 5 additional nuclei by means of systematics. The beta decay energies were also compared with 2 currently accepted mass formulas. In addition, an internal conversion electron measurement was made for the decay of 16-sec ^{140}Xe. Probable multipolarities for 18 gamma transitions in ^{140}Cs were determined and, on the basis of these multipolarities and the calculated log ft values for the beta fed levels in the decay scheme of ^{140}Cs, the spins and parities for 15 levels in this decay scheme are proposed. (auth)

54602 (JAERI-M-4666) BIBLIOGRAPHY FOR THERMAL NEUTRON SCATTERING, Supplement 1. (Japanese Nuclear Data Committee). Dec 1971. 17p. NTIS (U. S. Sales Only).

This is the supplement to the Third Edition of the Bibliography for Thermal Neutron Scattering (JAERI 4043). It contains 150 articles collected from June to October in 1971. These articles are needed for the evaluations of the thermal neutron scattering cross sections. (auth) (Japan)

54603 (JINR-P6-6511) STUDY OF THE ^{149}Tb DECAY. Vylov, Ts.; Gromov, K. Ya.; Gromova, I. I.; Iskhakov, G. I.; Kuznetsov, V. V.; Kuznetsova, M. Ya.; Lebedev, N. A.; Fominykh, M. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1972. 27p. (In Russian). Dep. NTIS (U. S. Sales Only).

Gamma-ray spectra and those of conversion electrons and $\gamma\gamma$-coincidences at the decay of ^{149}Tb are studied. For a number of transitions in ^{149}Gd nucleus the internal conversion coefficients are determined as well as the number of positrons in the ^{149}Tb decay. The positron intensity is (4.0 ± 0.2)% per decay of ^{149}Tb. The branching ratio for ^{149}Tb is determined from the γ-ray intensity of the daughter isotopes ^{149}Gd and ^{145}Eu. It is found to be (0.20 ± .02). The decay scheme ^{149}Tb → ^{149}Gd is suggested. (auth)

54604 (JINR-P6-6519) EXCITED QUASI-PROTON STATES IN MAGIC ^{141}Pr NUCLEUS. Buttsev, V. S.; Gromov, K. Ya.; Kalinnikov, V. G. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1972. 22p. (In Russian). Dep. NTIS (U. S. Sales Only).

The spectra of γ- and x-rays, $\gamma-\gamma$-coincidences, conversion electrons and positrons in the decay ^{141}Nd (2.42 ± 0.09 h) were thoroughly studied. Three new γ-transitions were found out. The energies of γ-transitions from the excited states of ^{141}Pr were more accurately determined. The multipolarities of 1126-91 keV – M1 + E2, 1147-30 keV – E2, 1292-64 – E2, 1298-60 – E2 transitions are determined. New levels of 1434-7 ($\frac{3}{2}^+$), 1456-1 keV ($\frac{5}{2}^+$) are introduced. Quantum characteristics are determined for the levels of the magic nucleus ^{141}Pr. The obtained experimental data are compared with the theoretical calculations, performed within the semimicroscopic models. (auth)

54605 (KFK-1602) DETERMINATION OF THE DISTRIBUTION OF THE CHARGE AND THE MAGNETIC DIPOLE MOMENT IN ^{93}Nb FROM THE MUONIC X-RAY SPECTRUM. Povel, H. P. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Experimentelle Kernphysik). May 1972. 177p. (In German). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Technische Hochschule, Karlsruhe (West Germany).

The muonic x-ray spectrum of ^{93}Nb has been measured with high resolution Ge(Li)-detectors. The following transitions have been observed: 2p–1s, 3d–2p, 3p–2s, 3s–2p and 2s–2p. The observation of the transitions from and to the 2s-level is important, because this level is next to the 1s-level most sensitive to the electromagnetic properties of the nucleus. From the measured energies and the hyperfine splitting (hfs) of the transitions the space distribution of the nuclear charge and the magnetic dipole moment have been determined. (auth)

54606 (ORNL-TM-3913) ELASTIC AND INELASTIC SCATTERING OF 12-MeV PROTONS FROM ^{92}Mo, ^{94}Mo, ^{96}Mo, AND ^{100}Mo: TABULATED DIFFERENTIAL CROSS SECTIONS. Dickens, J. K.; Eichler, E.; Silva, R. J.; Williams, I. R. (Oak Ridge National Lab., Tenn.). Sep 1972. Contract W-7405-eng-26. 23p. Dep. NTIS.

Numerical values of differential cross sections for elastic and inelastic scattering of 12.0-MeV protons from ^{92}Mo, ^{94}Mo, ^{96}Mo, and ^{100}Mo are reported in tabular form. Cross sections were determined at 5° intervals between laboratory angles of 20 and 165°. Inelastic scattering data are reported for 23 excited states of ^{92}Mo, 14 excited states of ^{94}Mo, 2 excited states of ^{96}Mo, and 6 excited states of ^{100}Mo. (auth)

54607 (RD/B/M-2356) AN ORDERED TABLE OF GAMMA RADIATION EMITTED BY FISSION PRODUCTS. Tobias, A. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Jun 1972. 180p. Dep. NTIS (U. S. Sales Only).

A set of data for the fission products of ^{235}U, ^{238}U, ^{239}Pu and ^{241}Pu is presented. In this compilation the energy of the gamma radiation emitted by each isotope is given, together with the number of photons per 100 disintegrations and the isotope half-life. The mass chains covered are 72-161 and 166 and the energies of the gamma radiation are given as accurately as they have been determined and are presented in increasing energy order. Almost 7,000 gamma lines are given. (auth)

54608 (UCRL-Trans-1473) EXPERIMENTS ON SEARCH FOR PROTON DECAY FROM THE GROUND STATE. Bogdanov, D. D.; Bochin, V. P.; Karnaukhov, V. A.; Petrov, L. A. (Joint Inst. for Nuclear Research, Dubna (USSR)). Translated by A. Habberton (Univ. of California Lawrence Berkeley Lab.), from report JINR-P6-6313. 25p. Dep. NTIS.

The neutron-deficient products from the reactions, induced by the accelerated ions of ^{32}S and ^{35}Cl in the targets of ^{96}Ru, ^{102}Pd, ^{106}Cd, ^{112}Sn, were studied. Using two techniques it is established that in bombarding ^{96}Ru by ^{32}S ions a proton emitter is produced having energy of 0.83 ± 0.05 MeV and half-life of about 1 sec. It is assumed that this group of protons appears in the decay of a light isotope of praseodymium (or lanthanum) from the ground state. (auth)

54609 COULOMB FLUX CORRECTIONS AND TOTAL CROSS SECTIONS FOR PION–NUCLEUS INTERACTIONS IN THE Δ-RESONANCE REGION. Faeldt, G. (Univ. of Lund, Sweden); Pilkuhn, H. Phys. Lett.; 40B: No. 6, 613-15(21 Aug 1972).

A relativistic generalization of the Blair model is shown to give large flux corrections (up to 20%) to pion–nucleus cross sections in the Δ-resonance region. Total cross sections for heavy nuclei are calculated and used in the evaluation of these corrections. The formulas also apply to incident high-energy protons. (auth)

54610 CONFIGURATION MIXING IN ^{90}Zr AND THE LIFETIME OF THE EXCITED 0^+ STATE. Courtney, W. J.; Fortune, H. T. (Univ. of Pennsylvania, Philadelphia). Phys. Lett.; 41B: No. 1, 4-6(4 Sep 1972).

Inclusion of $p_{\frac{1}{2}}$ core excitation in ^{90}Zr removes the previous factor-of-6 discrepancy between measured and calculated lifetime for decay of the first excited 0^+ state. (auth)

54611 INHIBITED TRANSITIONS AND ISOMERIC STATES IN THE N = 50 ISOTONES. Gloeckner, D. H. (Argonne National Lab., Ill. Univ. of Chicago); MacFarlane, M. H.; Lawson, R. D.; Serduke, F. J. D. Phys. Lett.; 40B: No. 6, 597-601(21 Aug 1972).

Measured E2 transition rates in the N = 50 isotones (^{90}Zr–^{94}Ru) are satisfactorily reproduced by a shell model with proton configurations $(p_{\frac{1}{2}}g_{\frac{9}{2}})^n$. The inhibited $8^+ \rightarrow 6^+$ E2 transition in ^{94}Ru and its connection with seniority mixing is discussed. Isomeric $1^7/_2^-$ states are predicted in ^{91}Nb and ^{93}Tc. (auth)

54612 LEVEL STRUCTURE OF ^{93}Mo AND THE FAILURE OF j-DETERMINATION BY SPECTROSCOPIC FACTOR RATIOS NEAR CLOSED SHELLS. Ball, J. B. (Oak Ridge National Lab., Tenn.). Phys. Lett.; 41B: No. 1, 55-8(4 Sep 1972).

The ^{95}Mo(p,t)^{93}Mo reaction is used to establish the 1.69-MeV level in ^{93}Mo as $\frac{5}{2}^+$ rather than $\frac{3}{2}^+$, as assigned in recent (d,p) and (d,t) studies. An explanation for this failure of j-value determination by comparison of spectroscopic factor ratios is presented. (auth)

54613 LEVELS OF ^{90}Nb EXCITED VIA THE ^{90}Zr(p,nγ) REACTION. Yoshida, Y. (Tokyo Inst. of Tech.); Ogawa, M.; Hattori, T.; (and others). Nucl. Phys.; A187: No. 1, 161-76(1972).

The excitation functions of the ^{90}Zr(p,nγ) reaction have been measured with a Ge(Li) detector to investigate the low-lying levels of ^{90}Nb and their γ-decay. The incident proton energy was varied from 6.90 to 9.50 MeV in steps of 100 keV. Thirty-four levels in ^{90}Nb which include those of the predominant $[(1g_{\frac{9}{2}})_\pi(1g_{\frac{9}{2}})_\nu^{-1}]J^\pi = 2^+ - 8^+$ and $[(2p_{\frac{1}{2}})_\pi(1g_{\frac{9}{2}})_\nu^{-1}]\ J^\pi = 4^-, 5^-$ configurations have been confirmed. A level with a predominant $[(1g_{\frac{9}{2}})_\pi(1g_{\frac{9}{2}})_\nu^{-1}]_{1^+}$ configuration is also suggested. The decay scheme of ^{90}Mo has been revised. (auth)

54614 SPECTROSCOPY OF ^{101}Mo BY SUB-COULOMB STRIPPING. Sievers, W. L.; Close, D. A.; Umbarger, C. J.; Bearse, R. C.; Prosser, F. W. Jr. (Univ. of Kanas, Lawrence). Phys. Rev., C; 6: No. 3, 1001-8(Sep 1972).

Sub-Coulomb stripping was employed to study ^{101}Mo with 3.75-MeV deuterons. Proton groups assigned to states in ^{101}Mo at excitation energies of 0, 57, 239, 290, 349, 480, 540, 561, 812, 851, and 898 keV were obeserved. The states at 349, 561, and 851 keV have not been reported previously. The ground state and the excited state at 349 keV were shown to be $\frac{1}{2}^+$ states with spectroscopic factors of 0.42 and 0.16. Tentative assignments of $l_n = 2$ were made for the states at 57, 239, 290, and 480 keV. If these states have a $\frac{3}{2}^+$ nature, the spectroscopic factors are 0.25, 0.09, 0.12, and 0.11, respectively. The sums of the spectroscopic fac-

tors for l = 0 and l = 2 transitions are shown to be consistent with previous results from stripping and pickup reactions on neighboring nuclei. (6 figures, 4 tables) (auth)

54615 COLLECTIVE EFFECTS SHOWN BY THE (p,t) REACTION ON THE CLOSED-SHELL NUCLEUS, ^{141}Pr. Goles, R. W.; Warner, R. A.; McHarris, Wm. C. (Michigan State Univ., East Lansing). Phys. Rev., C; 6: No. 2, 587-90(Aug 1972).

The reaction ^{141}Pr(p,t)^{139}Pr at 40 MeV strongly populates collective states in the residual nucleus. The shapes of the angular distributions, taken at 5° intervals between 15 and 65°, show the inadequacies even of finite-range, two-nucleon-pickup distorted-wave Born-approximation calculations and the need for inclusion of higher-order effects. (auth)

54616 STUDY OF SOME PROPERTIES OF TIN ISOTOPES THROUGH HIGH-ENERGY ALPHA-PARTICLE SCATTERING. Brissaud, I. (Institut de Physique Nucleaire, Orsay, France); Tatischeff, B.; Bimbot, L.; (and others). Phys. Rev. C; 6: No. 2, 595-606(Aug 1972).

Angular distributions of 166-MeV α particles scattered from the Sn isotopes 116, 118, 120, and 124 have been measured. An analysis of the elastic scattering data was performed using an optical potential calculated from an effective interaction between the α particle and a nuclear-matter distribution. The variation of nuclear sizes among the isotopes is considered. Assuming charge densities derived from the results of elastic electron scattering and/or mesonic atom data, values of neutron-matter radii for the tin isotopes are deduced which agree well with theoretical values. An analysis of the inelastic α-particle scattering to the first 2^+ and 3^- levels for each isotope was effected using the optical potentials calculated from the elastic scattering, the distorted-wave Born-approximation, and quasiparticle wave functions for the excited states. Electromagnetic transition rates and form factors for electron scattering were calculated with the same wave functions, and a comparison of the calculations to the experimental results provides information about the proton and neutron configurations in these isotopes. (auth)

54617 DOUBLE K-SHELL IONIZATION IN THE DECAY OF ^{131}Cs AND ^{165}Er. Nagy, H. J.; Schupp, G.; Hurst, R. R. (Univ. of Missouri, Columbia). Phys. Rev., C; 6: No. 2, 607-12(Aug 1972).

Double ionization of the K shell has been studied in the electron capture decays of ^{131}Cs and ^{165}Er by recording coincidences between K x rays emitted when the double vacancies are filled. A Si(Li) x-ray detector was used in conjunction with a NaI(Tl) detector for these measurements. The results obtained for P_{KK}, the probability per K capture that a double K-shell vacancy is formed, were $(1.33 \pm 0.33) \times 10^{-5}$ for ^{131}Cs and $(6.7 \pm 3.9) \times 10^{-6}$ for ^{165}Er. Both of these values are a factor of 2 smaller than previous measurements and, within the experimental uncertainties, are in agreement with predictions based on the relativistic theory of Intemann. (auth)

54618 ^{142}Ce(d,p) AND ^{142}Ce(d,t) REACTIONS AND ISOBARIC ANALOG RESONANCES IN ^{142}Ce(p,p_0) AND ^{142}Ce(p,p_1). Lessard, L.; Gales, S.; Foster, J. L. Jr. (Univ. of Montreal). Phys. Rev., C; 6: No. 2, 517-31(Aug 1972).

The reactions ^{142}Ce(d,p) and ^{142}Ce(d,t) at an incident deuteron energy of 12.6 MeV have been investigated with an energy resolution of about 16 keV, and excitation functions for the reactions ^{142}Ce(p,p_0) and ^{142}Ce(p,p_1) have been measured from 9.5- to 12-MeV incident proton energies. The analysis of the analog resonances observed in the excitation functions is compared with the results of the ^{142}Ce(d,p) experiment. (auth)

54619 LEVEL SCHEME OF ^{144}Sm DETERMINED BY THE (γ,γ') REACTION. Arad, B. (Soreq Nuclear Research Center, Yavne, Israel. Bar-Ilan Univ., Ramat Gan, Israel); Ben-David, G.; Schlesinger, Y.; Hass, M. Phys. Rev., C; 6: No. 2, 670-2(Aug 1972).

The 8.998-MeV resonance level excited by the (γ,γ') reaction, which was previously assigned to ^{150}Sm, is shown to belong to ^{144}Sm. The level scheme of ^{144}Sm is given and the reevaluated level parameters of the 8.998-MeV resonance are presented. (auth)

54620 STRUCTURE OF THE LOW-LYING STATES OF THE ODD-A In ISOTOPES. Sen, S. (Saha Inst. of Nuclear Physics, Calcutta). Nucl. Phys.; A191: No. 1, 29-46(1972).

The level schemes and electromagnetic properties of odd-A In isotopes from A = 113 to A = 117 are calculated in a semi-microscopic model which couples the proton-hole motion to the quadrupole and octupole vibrations of the core. The calculated results are compared with recent experimental findings. The addition of octupole vibration is necessary to explain the properties of the negative-parity states. It is found that this coupling scheme is not adequate to explain in detail the observed properties of the positive-parity states. Calculation is also done by mixing the hole-core coupled states with the states forming a $K = \frac{1}{2}^+$ rotational band; good agreement with experimental data is obtained. (auth)

54621 PHASE AND SHAPE OF THE FORM FACTOR FOR INELASTIC ^{3}He SCATTERING. Baker, F. T. (Rutgers–The State Univ., New Brunswick, N. J.); Kruse, T. H.; Williams, M. E.; Matthews, J. L.; Savin, W. Phys. Lett.; 40B: No. 3, 355-6(10 Jul 1972).

Interference between nuclear and Coulomb excitation of the 0.56 MeV 2^+ state of ^{114}Cd by ^{3}He particles with energies near the Coulomb barrier has been observed. The results indicate that the collective model describes the data well and that the form factor for inelastic ^{3}He scattering is therefore largely imaginary. (auth)

54622 LIFETIME OF THE FIRST EXCITED STATE IN ^{96}Zr. Burch, D.; Russo, P.; Swanson, H.; Adelberger, E. G. (Univ. of Washington, Seattle). Phys. Lett.; 40B: No. 3, 357-9(10 Jul 1972).

The reaction ^{96}Zr(p,p'e) was used to measure the lifetime of the 0_2^+(1.59 MeV) state in ^{96}Zr through the observation of delayed coincidences between a pulsed proton beam and the E0 internal conversion electrons. The half-life is 3.80 ± 1.5 ns. This value is compared to a simple shell model calculation. (auth)

54623 MULTIPLE COULOMB INTERFERENCE EFFECTS ON THE QUADRUPOLE MOMENT OF ^{114}Cd. Larsen, R. D.; Thomson, J. A.; Kerr, R. G.; Scharenberg, R. P.; Lutz, W. R. (Purdue Univ., Lafayette, Ind.). Phys. Lett.; 40B: No. 3, 360-2(10 Jul 1972).

The sign of the multiple Coulomb interference term in ^{114}Cd was determined to be positive by comparing low and high excitation probability experiments. With this sign the quadrupole moment of the first 2^+ state was found to be $Q(2^+) = -0.35 \pm 0.07$ b. (auth)

54624 MOESSBAUER OBSERVATION OF THE MAGNETIC MOMENT OF THE 89-keV EXCITED STATE OF ^{119}Sn. Gumprecht, D. F. (Helsinki Univ. of Tech., Otaniemi, Finland); Katila, T. E.; Moberg, L. C.; Lipas, P. O. Phys. Lett.; 40A: No. 4, 297-8(31 Jul 1972).

The magnetic moment of the 89-keV excited state of ^{119}Sn was determined from Mössbauer measurements made below 100 mK. The value obtained was $-1.40 \pm 0.08\ \mu_N$. Its deviation from the Schmidt value $-1.91\ \mu_N$ is consistent with systematics and nuclear theory estimates. (auth)

54625 RELATIVE ISOTOPE SHIFT (112−114)/(110−112) IN THE λ = 4416 A LINE OF CADMIUM. Gerstenkorn, S.; Helbert, J. M.; Lecordier, R. (CNRS, Orsay, France. Faculte des Sciences, Rouen). Phys. Lett.; 40A: No. 3, 229-30(17 Jul 1972). (In French).

The relative isotope shift $\Delta(112-114)/\Delta(110-112)$ in the spectral line $\lambda = 4416$ Å ($d^{10}p\ ^2P_{\frac{1}{2}} - d^9\ s^2\ ^2D_{\frac{1}{2}}$) was investigated and found to be 0.87 ± 0.02. The decrease of the isotope shifts between A = 110 and A = 116 is compared to the decrease of the quantities $EA^{\frac{1}{2}}$ where E is the binding energy per nucleon. (auth)

54626 CUMULATIVE YIELD OF 83-SEC ^{136}I FROM THERMAL-NEUTRON INDUCED FISSION OF ^{235}U. Wahl, A. C.; Denig, R. (Washington Univ., St. Louis). J. Inorg. Nucl. Chem.; 34: No. 8, 2413-18(Aug 1972).

The cumulative yield of 83-sec ^{136}I from thermal-neutron induced fission of ^{235}U was redetermined to be 4.3 ± 0.4% if formed independently or 3.4 ± 0.4% if formed by beta decay of 21-sec ^{136}Te. The median value of 3.9 ± 0.8% is recommended since the mode of formation is not known. Allowing for an appreciable yield of the 44-sec ^{136}I isomer, as observed by Lundán, the fractional independent yield of ^{136}Xe is 0.24 ± 0.18, which is within the estimated "normal" range of 0.17 ± 0.07. Thus, there is no longer evidence for yield enhancement of $^{136}Xe_{82}$ associated with closure of the 82-neutron shell. (auth)

54627 ISOMER RATIOS OF ^{95}Nb FORMED IN THE FISSION OF ^{209}Bi. Rao, C. L.; Saha, G. B.; Yaffe, L. (McGill Univ., Montreal). J. Inorg. Nucl. Chem.; 34: No. 8, 2397-2403(Aug 1972).

Analysis of the isomer ratios of the symmetric fission product, ^{95}Nb, formed in the fission of ^{209}Bi reported by Hagebo (J. Inorg. Nucl. Chem. 27, 927(1965)), in the energy range of 55 to 157 MeV, was made according to the energy-dependent calculation of Saha and Yaffe (J. Inorg. Nucl. Chem. 31, 1891(1969)). Values of angular momentum 8$\hbar$ at 55 MeV to 15$\hbar$ at 157 MeV were found. These values agree with those calculated from isomer ratios in the heavy-mass region in the fission of heavier elements. (auth)

54628 ISOMER YIELD RATIOS OF ^{115m}Cd AND ^{115g}Cd. Rao, S. A. (Univ. of Arkansas, Fayetteville). J. Inorg. Nucl. Chem.; 34: No. 8, 2405-11(Aug 1972).

The cumulative isomer yield ratios σ_m/σ_g of the ^{115}Cd isomers were measured for the reactions ^{116}Cd(n,2n), ^{118}Sn(n,α), ^{232}Th(n,f),

and $^{238}U(n,f)$ by 14.8 MeV neutrons. The ratios of the 43 day $^{115m}Cd(11/2^-)$ yield to the 2.3 day $^{115g}Cd(1/2^+)$ yield are 0.71 ± 0.06, 1.48 ± 0.20, 0.088 ± 0.015, and 0.12 ± 0.02 for the respective reactions. The most probable excitation energies of the compound nuclei, in the formation of ^{115}Cd isomers from various reactions, were calculated. From the knowledge of the threshold energies for these reactions, it is suggested that there is a relation between cumulative isomer yield ratios and excitation energies above the threshold. (auth)

54629 PHOTONEUTRON CROSS SECTIONS OF ^{139}La AND ^{141}Pr. Deague, T. K.; Stewart, R. J. J. (Univ. of Melbourne, Parkville, Australia). Nucl. Phys.; A191: No. 2, 305-20(1972).

The cross sections for photoneutron production in ^{139}La and ^{141}Pr have been measured from threshold to 24 MeV and 22 MeV respectively by direct neutron detection. A modified Penfold-Leiss method, with an analysis bin optimized at all energies, was used to unfold these cross sections from bremsstrahlung yield data. The results are compared with predictions of the dynamic collective model and a recent collective-correlations calculation. Most of the apparent contradictions between recent measurements of the ^{141}Pr (γ,n) cross section from threshold to 17 MeV can be resolved through (i) a more efficacious choice of bremsstrahlung yield-curve analysis technique, and (ii) a consideration of comparative experimental resolutions and uncertainties. (auth)

54630 COULOMB EXCITATION OF NUCLEI BY HEAVY POLARIZED PARTICLES. Davydov, A. V.; Narodetskii, I. M. (Inst. of Theoretical and Experimental Physics, Moscow). JETP Lett. (USSR) (Eng. Transl.); 15: No. 12, 525-8(20 Jun 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 15: No. 12, 741-5(20 Jun 1972).

Existing methods for determining the magnetic moments of short-lived nuclear states are feasible only for states with lifetimes longer than $\sim 10^{-11}$ s. Another method for determining the magnetic moment (m.m.), based on Coulomb excitation of nuclei by polarized particles, is described. A charged-particle magnetic field greatly exceeding that of laboratory fields is used, and the entire process occurs during the time of flight of the particle past the nucleus; hence, it is independent of the lifetime of the nucleus in the excited state. The difference $\sigma\uparrow - \sigma\downarrow$, where $\sigma\uparrow(\sigma\downarrow)$ is the cross section for the Coulomb excitation for a spin directed parallel (antiparallel) to the normal to the reaction plane, is determined by the m.m. of the excited state. By measuring this difference (or the left–right asymmetry in scattering) the m.m. of the excited state can be determined experimentally. The appropriate theory underlying the method is developed, and results are given for ^7Li and ^{148}Sm and ^{17}O on ^{64}Zn. (1 figure, 1 table) (R.W.R.)

Nuclear Properties and Reactions, 150 ≤ A ≤ 189

Refer also to abstracts 54523, 54563, 54585, 54589, 54597, 54598, 54617, 54630, 54656, 54672, 54881, and 54960.

54631 (BNL-tr-490) CORRELATION OF THE PARTIAL RADIATION WIDTHS IN THE REACTION $^{163}Dy(n,\gamma)^{164}Dy$. Danelyan, L. S.; Demidov, A. M.; Krupin, S. V.; Sotnikov, S. K.; Zarandi, A.; Kardon, B.; Szabo, L.; Seres, Z. Translated by S. J. Amoretty (Brookhaven National Lab., Upton, N. Y.), from Zh. Eksp. Teor. Fiz.; 62: No. 2, 425-9(1972). 8p. Dep. NTIS.

The γ ray spectra in the $^{163}Dy(n,\gamma)^{164}Dy$ reaction were investigated with a Ge(Li) spectrometer. A number of phenomena of a nonstatistical nature are observed: correlations between the reduced radiative and neutron widths and between various partial radiative widths. The absolute mean reduced partial width is greater than any of those predicted by the various models or based on the experimental data for other nuclei. The degree of freedom of the partial width distribution for transitions to the ground rotational and γ vibrational bands is $\nu = 2 \pm 0.5$. (auth)

54632 (COO-3255-2) DECAY OF ^{161}Er TO LEVELS IN ^{161}Ho. Wood, J. L.; Brenner, D. S. (Clark Univ., Worcester, Mass. (USA). Jeppson Lab. of Chemistry). 8 Jul 1971. 50p. Dep. NTIS.

The gamma-ray spectrum of the decay chain $^{161}Er \rightarrow {}^{161}Ho \rightarrow {}^{161}Dy$ has been studied with Ge(Li) detectors. Results of γ-ray singles and coincidence experiments are reported and a decay scheme for $^{161}Er \rightarrow {}^{161}Ho$ is proposed. Asymptotic quantum-number assignments are made for several new energy levels in ^{161}Ho and the results are compared to predictions of the unified model. No evidence was found for the population of three-quasiparticle states in ^{161}Ho. Deexcitation of the $3/2^-$ $\{1/2^-[523],2^+\}$ γ-vibrational state and Coriolis coupling in the $1/2^+[411]$ rotational band are discussed. (auth)

54633 (COO-3255-3) LEVELS IN ^{186}Os AS POPULATED BY THE DECAY OF ^{186}Ir. Hofstetter, K. J. (Texas Agricultural and Mechanical Univ., College Station. Kentucky Univ., Lexington, Dept. of Chemistry); Sugihara, T. T. (Texas Agricultural and Mechanical Univ., College Station); Brenner, D. S. (Clark Univ., Worcester, Mass. (USA). Jeppson Lab. of Chemistry). 1971. 48p. Dep. NTIS.

The excited level scheme of ^{186}Os as populated by the decay of 15.8-h ^{186}Ir has been studied by Ge(Li) detectors in singles and coincidence spectrometers. The coincidence data confirm essentially all of the previously known intraband and interband transitions assigned to the ground-state band (to the 6^+ level), the γ-band (to the 7^+ level) and to the J = 4, 5, and 6 members of a two-phonon K = 4 band. Coincidence data also establish levels at 1194.45 (4^+), 1461.09 (4^+), 1480.3 (4^+), 1628.3 (5^-), 1775.8 (6^+), 1812.5 (5^+), 1875.40 (4^+), 2056.38 (5^+), 2081.21 (4^+), 2377.3 (6^+), and 2771.7 (4^+) keV. The J^π assignments are based on multipolarities determined from internal conversion coefficients. Additional levels based on energy sums are tentatively proposed at 1582.3, 2661.2, 3041.3, 3151.7, 3268.8 and 3413.6 keV. An analysis of the interband transition intensities between members of the γ-band and members of the ground-state band indicates that the first-order band-mixing model fits the data. The mixing parameter z_γ is found to have the value 0.087 ± 0.004 for ^{186}Os. The 15.8-h ^{186}Ir state is believed to be a 6^+ state with the Nilsson configuration $\pi 11/2^-[505] + \nu 1/2^-[510]$. (auth)

54634 (JINR-E6-6479) g-FACTOR OF THE 108 keV EXCITED STATE IN ^{151}Gd. Afanas'ev, V. P.; Fuya, Kh.; Gromov, K. Ya.; Gromova, I. I.; Ion-Mikhai, R.; Khalikulov, A. B.; Monchka, D.; Morozov, V. A.; Muminov, T. M.; Zhuk, V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1972. 12p. Dep. NTIS (U. S. Sales Only).

Measurements of the integral perturbed angular correlation (IPAC) were made using magnetic hyperfine interactions. The $^{151,155}Tb$ radioactive nuclei were embedded in iron foil by the use of an isotope separator. The measurements of the g-factor of the 108 keV state in ^{151}Gd have yielded a value of $(-0.54^{+0.03}_{-0.10})$. (auth)

54635 (JINR-P4-6509) ONE-NUCLEON TRANSFER REACTIONS TO QUASI-INTERSECTING LEVELS $1/2^+$ (660) AND $1/2^+$ (400), $3/2^+$ (651) AND $3/2^+$ (402). Gareev, F. A.; Bazhat, M.; Vibike, Kh. I.; Shul'ts, G. (Joint Inst. for Nuclear Research, Dubna (USSR). Theoretical Physics). 1972. 20p. (In Russian). Dep. NTIS (U. S. Sales Only).

Based on the coupled channel method, the (d,t) reactions on ^{160}Gd and ^{164}Dy nuclei are considered taking account of $\Delta N = \pm 2$ mixing of states $1/2^+[660]$ and $1/2^+[400]$, $3/2^+[651]$ and $3/2^+[402]$. The results show that this method allows one to give a satisfactory description of the transfer reaction cross sections to these states. When including the Coriolis interaction between the states, where stripping takes place, the cross sections change by 30%. (auth)

54636 SINGLE-NEUTRON-TRANSFER-REACTION STUDIES OF ^{176}Hf AND ^{180}Hf. Zaitz, J. I.; Sheline, R. K. (Florida State Univ., Tallahassee). Phys. Rev., C; 6: No. 2, 506-17(Aug 1972).

The strongly deformed even-even nuclei ^{176}Hf and ^{180}Hf have been studied using the reactions $^{177}Hf(d,t)^{176}Hf$ and $^{179}Hf(d,p)$ ^{180}Hf. These reactions were performed at 12- and 14-MeV incident energy on the Florida State University super FN tandem Van de Graaff accelerator with the outgoing particles analyzed by means of a Browne–Buechner-type broad-range magnetic spectrograph. 25 states associated with two-quasiparticle rotational bands have been identified or tentatively identified in these nuclei; included are the intrinsic band heads $6^+[514\downarrow + 512\uparrow]$, $3^+[514\downarrow - 521\downarrow]$, $4^+[514\downarrow + 521\downarrow]$, and $6^+[514\downarrow + 523\downarrow]$ in ^{176}Hf and the intrinsic band heads $4^-[624\uparrow - 510\uparrow]$, $5^-624\uparrow + 510\uparrow]$, $6^-[624\uparrow + 512\downarrow]$, and $8^-[624\uparrow + 503\uparrow]$ in ^{180}Hf. Coriolis-mixing calculations have been an important factor in making the state assignments. (auth)

54637 NUCLEAR LEVELS IN ^{188}Re. Shera, E. B. (Los Alamos Scientific Lab., N. Mex.); Gruber, U.; Maier, B. P. K.; (and others). Phys. Rev., C; 6: No. 2, 537-67(Aug 1972).

Nuclear levels in ^{188}Re have been investigated using the following experimental techniques: measurement of neutron-capture γ-ray transitions with energies between 4.8 and 6.0 MeV using a Ge(Li) pair spectrometer; study of (d,p) spectra using 12-MeV deuterons and a broad-range magnetic spectrograph; measurement of (n,γ) spectra between 45 and 830 keV with a bent-crystal spectrometer; coincidence studies of the (n,γ) radiation using two Ge(Li) detectors, including a study of short-lived isomeric states using delayed-coincidence techniques; and observation of the γ rays following β decay of ^{188}W using a Ge(Li) detector. A nuclear level scheme for ^{188}Re has been constructed by combining the results of the above measurements with published data. Information, including spin and parity assignments, is presented on 36 low-lying levels.

The lifetimes of five excited states are reported. The Nilsson model has been used to interpret the level structure. Assignments are proposed which involve 15 separate rotational bands. Proposed Nilsson configurations, band-head energies, and band-head lifetimes (if known) are: $1^-[402\uparrow - 512\downarrow]$, 0.0 keV; $3^-[402\uparrow + 510\uparrow]$, 169.4 keV, $6^-[402\uparrow + 503\uparrow]$, 172.1 keV, 19 min; $4^-[402\uparrow + 512\downarrow]$, 182.7 keV, 18 nsec; $2^-[402\uparrow - 505\downarrow]$, 205.3 keV, 3.2 nsec; $0^+[514\uparrow - 505\downarrow]$, 207.9 keV, 3.2 nsec; $3^+[514\uparrow - 512\downarrow]$, 230.9 keV, 21 nsec; $2^-[402\uparrow - 510\uparrow]$, 256.9 keV; $1^-[402\uparrow + 503\uparrow]$, 290.7 keV; $4^-[402\uparrow + 501\uparrow]$, 325.9 keV; $5^+[514\uparrow + 510\uparrow]$, 360.9 keV, 5.2 nsec; $3^+[402\uparrow - 615\uparrow]$, 439.7 keV; $1^+[514\uparrow - 503\uparrow]$, 482.2 keV; $1^-[402\uparrow - 501\uparrow]$, 556.8 keV. A $K^\pi = 1^-$ band, believed to be predominantly a $|K-2|$ γ-vibrational band, is observed at 582.2 keV. The measured (d,p) reaction cross sections are compared with theoretical calculations based on these assignments. The β-decay measurements have revealed a previously unknown β branch from the ^{188}W ground state to a $I^\pi = 0^+$ level at 207.9 keV. This $0^+ \rightarrow 0^+$ transition (logft = 9.9) is discussed in terms of isobaric analog state mixing. Results of a calculation which uses a parametrized residual neutron–proton interaction to predict the parallel-antiparallel splitting energies and K = 0 even-odd shifts in ^{186}Re and ^{188}Re are presented and compared with experiment. (auth)

54638 STATIC QUADRUPOLE MOMENTS OF THE FIRST 2^+ STATES OF THE EVEN–EVEN OSMIUM NUCLEI. Lane, S. A.; Saladin, J. X. (Univ. of Pittsburgh). Phys. Rev., C; 6: No. 2, 613-18(Aug 1972).

Measurements of the total thick-target yields of γ rays deexciting the first 2^+ excited states of ^{192,190,188,186,184}Os following Coulomb excitation by helium, oxygen, and sulfur ions have been made. These measurements were compared with theoretically calculated yields in order to extract linear combinations of the static electric quadrupole moments of the 2^+ states. The results were compared with the measurements of Pryor and Saladin of the absolute moments of ^{192,190,188}Os in order to obtain the best combined values for these three isotopes, as well as absolute values for ^{186,184}Os. These values are -0.50 ± 0.20, -0.95 ± 0.19, -1.32 ± 0.43, -1.47 ± 0.54, and -2.4 ± 1.1, respectively. For the isotopes ^{192,190,188,186}Os the $B(E2, 0^+ \rightarrow 2^+)$ values determined in the experiment agree with published values to within 10%. The $B(E2, 0^+ \rightarrow 2^+)$ value of ^{184}Os was previously unknown and was determined to be 3.20 ± 0.62 e^2b^2. The results are also compared with the model calculations of Kumar and Baranger and found to be in good agreement. (auth)

54639 DECAY OF ^{162}Yb. Chu, Y. Y. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., C; 6: No. 2, 628-30(Aug 1972).

The decay of ^{162}Yb was studied with samples produced by irradiating ^{164}Er with 52-MeV ^{3}He ions. Mass separation of the irradiated samples provided isotopically pure ^{162}Yb samples for half-life and γ-ray spectra measurements. Three γ rays (44-, 118-, and 162-keV in energy) as well as the Tm K x rays were observed and the half-life of ^{162}Yb was determined to be 18.87 ± 0.19 min. The latter two γ rays were found only in coincidence with Tm K x rays but not with each other. From the growth and decay of the 102-keV γ ray of ^{162}Tm in these same samples, the abundances of the three γ rays and the Tm Kα_1 x ray were determined. (auth)

54640 EFFECT OF CHANGES IN EQUILIBRIUM DEFORMATIONS OF THE EXCITED STATES OF ODD-A DEFORMED NUCLEI ON THEIR ENERGY AND STRUCTURE. Arsen'ev, D. A.; Fedotov, S. I.; Pashkevich, V. V.; Solov'ev, V. G. (Joint Inst. for Nuclear Research, Dubna, USSR). Phys. Lett.; 40B: No. 3, 305-6 (10 Jul 1972).

In the present note the results of calculations of the equilibrium deformations of the excited states of odd-A nuclei in the region $153 \leq A \leq 177$ are reported. For the states with $\beta_e \neq \beta_0$ the energy and the structure are calculated with the account of the quasiparticle-phonon interaction. (auth)

54641 $0^+ \rightarrow 0^+$ β TRANSITION OF ^{188}W. Shera, E. B. (Los Alamos Scientific Lab., N. Mex.); Ikeda, A.; Sheline, R. K. Phys. Lett.; 40B: No. 3, 349-51(10 Jul 1972).

A β-transition with a log ft value of 9.9 has been observed between the ^{188}W 0^+ ground state and a 0^+ state at 207.9 keV in ^{188}Re. This highly forbidden Fermi transition can be quantitatively interpreted in terms of the mixing of the isobaric analog state of the ^{188}W ground state into the ^{188}Re$\{\pi\, 9/2^-[514\uparrow] - \nu\, 9/2^-[505\downarrow]\}0^+$ state. (auth)

54642 MEASUREMENT OF LIFETIMES IN ^{152}Sm, ^{154}Gd, AND ^{156}Gd BY DOPPLER-SHIFT RECOIL-DISTANCE TECHNIQUES. Rud, N. (Queen's Univ., Kingston, Ont.); Ewan, G. T.; Christy, A.; (and others). Nucl. Phys.; A191: No. 3, 545-60(1972).

The following lifetimes (in ps) were measured for the states in ^{152}Sm: 4_g: 82.8 ± 1.2, 6_g: 14.6 ± 0.4, 8_g: 4.3 ± 0.65, 0_β: 8.92 ± 0.55; in ^{154}Gd: 4_g: 66.3 ± 2.2, 6_g: 11.2 ± 0.6, 0_g: 5.7 ± 0.9; and in ^{156}Gd: 4_g: 163 ± 7 and 6_g: 20.5 ± 1.75. The Doppler-shift recoil-distance method was used in which the states were populated by Coulomb excitation using 100-MeV ^{35}Cl ions. Gamma rays were detected in coincidence with back-scattered ^{35}Cl ions. The results for the 0_β lifetimes are discussed in terms of the monopole matrix elements between the ground state and β-vibrational bands. Deviations from rotational behavior in the ground-state-band transition probabilities are found to be consistent with the simple band-mixing picture. (12 figures, 5 tables) (auth)

54643 NUCLEAR SPECTROSCOPY OF NEUTRON-DEFICIENT La, Dy, AND Er ACTIVITIES. Harmatz, B.; Handley, T. H. (Oak Ridge National Lab., Tenn.). Nucl. Phys.; A191: No. 3, 497-524(1972).

A large accumulation of conversion-electron data made it feasible to study the properties of nuclear levels in the rare earth region of neutron numbers 88 to 94. The first experimental level scheme for ^{153}Tb (N = 88) is constructed; 84 transitions originate from 21 states excited below 1 MeV. The conversion spectrum of ^{155}Tb is augmented from 40 to 120 transitions below 1.1 MeV energy. Multipole orders are deduced for 55 of the 96 transitions placed between 28 levels in ^{155}Tb. Rotational parameters and γ-ray branching ratios are evaluated for ^{155}Tb. Levels in the 0.5 to 1 MeV region are interpreted as β and γ vibrations of the $3/2^+[411]$ state and a single-particle $1/2^+[411]$ band. Data on ^{158}Ho consists of 41 transitions, of which 30 are new, and almost all of the transition intensity is accounted for in the level spectrum. Neutron orbital $3/2^-[521]$ is found to be common to each of four low-lying intrinsic configurations in doubly odd ^{158}Ho. The order of odd-proton orbitals coupled to $3/2^-[521]$ corresponds to that of single-particle states observed in neighboring ^{159}Ho. Eighty conversion-electron transitions were observed below 1 MeV in ^{161}Ho, a six-fold increase over preceding studies. By using photon intensities from independent research, multipole orders are deduced for most of the transitions de-exciting 18 nuclear levels in ^{161}Ho. More evidence is presented on decay spectra of ^{131,132m}La, including transition multipolarity assignments. (auth)

54644 MULTIPOLE MIXING RATIOS OF γ-TRANSITIONS IN ^{185}Re. Behar, M.; Grabowski, Z. W.; Steffen, R. M. (Purdue Univ., Lafayette, Ind.). Nucl. Phys.; A191: No. 2, 361-7(1972).

Gamma-gamma directional correlation experiments were performed on four cascades in ^{185}Re populated from the electron capture decay of ^{185}Os (94 d). Two Ge(Li) detectors in a coincidence arrangement were used in this measurement. The directional correlation coefficients for the 173 keV–593 keV γ-γ cascade together with previously determined conversion coefficients give a unique spin $1/2^+$ assignment for the 879 keV level. The E2/M1 mixing ratios for the 125 keV, 163 keV and 718 keV transitions are $\delta(125) = 0.186 \pm 0.019$, $\delta(163) = 0^{+0.06}_{-0.024}$ and $\delta(718) = -2.23 \pm 0.06$, respectively. (auth)

54645 COLLECTIVE AND HIGHER-ORDER EFFECTS SHOWN BY THE (p,t) REACTION ON THE DEFORMED NUCLEUS ^{159}Tb. Goles, R. W.; Warner, R. A.; McHarris, Wm. C. (Michigan State Univ., East Lansing). Phys. Rev. Lett.; 29: No. 12, 802-5(18 Sep 1972).

The reaction ^{159}Tb(p,t)^{157}Tb at 30 MeV strongly populates collective states in the residual nucleus. Angular distributions of β and γ vibrational and ground-state rotational band members are presented and compared with distorted-wave Born-approximation predictions. Evidence supporting the importance of indirect multiple-step processes accompanying (p,t) reaction is also included. The (p,t) reaction is shown to be a powerful spectroscopic tool for populating higher-lying rotational band members in odd-mass deformed nuclei. (auth)

54646 OBSERVATION OF TEMPERATURE SPIKES FOLLOWING COULOMB EXCITATION. Hardy, K. A. (Johns Hopkins Univ., Baltimore); Walker, J. C.; Shnidman, R. Phys. Rev. Lett.; 29: No. 10, 622-5(4 Sep 1972).

Short-lived temperature spikes were observed following Coulomb excitation in rare earth oxides. The thermal aftereffects were detected by observing the Moessbauer effect in the decay of Coulomb excited states of ^{165}Ho, ^{175}Lu, and ^{167}Er. The results are in reasonable agreement with a simple model based on heat-flow theory. (auth)

Nuclear Properties and Reactions, 190 ≤ A ≤ 219

Refer also to abstracts 54501, 54528, 54529, 54547, 54563, 54597, 54598, 54602, 54609, 54627, 54628, 54630, and 54638.

54647 $4^+ \rightarrow 0^+$ CROSS-OVER TRANSITION IN ^{204}Pb. Signorini, C.; Morinaga, H. (Technische Univ., Munich). Phys. Lett.; 40B: No. 5, 549-50(7 Aug 1972).

A $4^+ \rightarrow 0^+$ cross-over γ-ray decay in ^{204}Pb was detected. The branching ratio of this transition to the $4^+ \rightarrow 2^+ \rightarrow 0^+$ cascade was measured to be $(0.012 \pm 0.002)\%$. (auth)

54648 SPECTRAL SHAPE AND NUCLEAR MATRIX ELEMENTS IN THE β-DECAY OF ^{206}Tl. Wiesner, W. (Univ., Heidelberg); Flothmann, D.; Gils, H. J.; Loehken, R.; Rebel, H. Nucl. Phys.; A191: No. 1, 166-76(1972).

The spectral shape, endpoint energy and half-life of the β-decay of ^{206}Tl were measured. The β-particles were analyzed in a 4π Si(Li) sandwich spectrometer. The sources used were isotopically separated and therefore extremely thin. The measured spectrum was corrected for the escape of bremsstrahlung. The extracted shape factor shows only small deviations from the statistical form, the endpoint energy of the decay is 1527 ± 4 keV, its half-life 4.27 ± 0.05 min. The nuclear matrix elements of this $0^- \rightarrow 0^+$ decay have been calculated from single-particle wave functions. The resulting theoretical spectral form describes the experimental data very well, whereas the total transition probability is underestimated theoretically by a factor of 7. (auth)

54649 INVESTIGATION OF SOME LOW-LYING STATES IN ^{208}Pb BY INELASTIC ELECTRON SCATTERING. Friedrich, J. (Univ., Mainz). Nucl. Phys.; A191: No. 1, 118-36(1972).

Differential cross sections for inelastic electron scattering from ^{208}Pb have been measured in the momentum-transfer range from 0.48 fm^{-1} to 1.54 fm^{-1}. The cross sections for the excitation of the 3^- level at 2.6 MeV cannot be reproduced with a modified liquid-drop model using a two-or three-parameter Fermi distribution, but are instead consistent with a phenomenological distribution which consists of two Gaussian functions multiplied with r^{L-1}. The value obtained for the reduced transition probability $B(0.624 \pm 0.04$ b$^5)$ is somewhat different from that determined in earlier electron scattering experiments. The cross sections for the excitation of the two 5^- levels at 3.2 and 3.7 MeV exhibit a striking difference in that the ratios of the cross section in the two first diffraction maxima are different by a factor of 2.5. The cross sections for the excitation of the level at 3.2 MeV can be reproduced with the modified liquid-drop model using a three-parameter Fermi distribution. The value for B is determined to be 0.053 ± 0.014 b^5. The excitation of the level at 3.7 MeV cannot be described by this model. There are strong indications that the transition charge here consists of two regions with opposite sign. (auth)

54650 EFFECTS OF ^{208}Pb CORE VIBRATIONS ON SHELL-MODEL CALCULATIONS FOR ^{211}At AND ^{211}Pb. Ewart, G. M.; Gerace, W. J.; Walker, James F. (Univ. of Massachusetts, Amherst). Nucl. Phys.; A191: No. 3, 596-608(1972).

The low-lying states of ^{211}Pb and ^{211}At are described as three $j = 9/2$ particles coupled to each other and to a ^{208}Pb core. The core states are restricted to zero- or one-quadrupole-phonon excitations. All model parameters are determined uniquely from the available experimental data on nuclei having A = 208, 209, 210. The resulting wave functions and energy levels are given. Reduced transition probabilities for E2 transitions between the states of ^{211}At are calculated and compared with experiment. Good agreement is achieved. (2 figures, 5 tables) (auth)

54651 IN-BEAM α SPECTROSCOPY OF N = 128 ISOTONES. LIFETIMES OF ^{216}Ra AND A NEW ISOTOPE ^{217}Ac. Nomura, T.; Hiruta, K.; Inamura, T.; Odera, M. (Inst. of Physical and Chemical Research, Saitama, Japan). Phys. Lett.; 40B: No. 5, 543-5 (7 Aug 1972).

By means of the pulsed-beam technique a new isotope, ^{217}Ac, was found to decay with $E_\alpha = 9.65 \pm 0.02$ MeV and $\tau_{1/2} = 0.10 \pm 0.01$ μs. The half-life of ^{216}Ra was determined to be 0.18 ± 0.03 μs. (auth)

Nuclear Properties and Reactions, A ≥ 220

Refer also to abstracts 53803, 54602, 54607, 54626, 54630, and 54960.

54652 (ANCR-1069) GAMMA RAYS EMITTED BY THE FISSIONABLE NUCLIDES AND ASSOCIATED ISOTOPES. Cline, J. E.; Gehrke, R. J.; McIsaac, L. D. (Aerojet Nuclear Co., Idaho Falls, Idaho). Jul 1972. Contract AT(10-1)-1375. 51p. Dep. NTIS.

Supplement to IN-1448.

New data on gamma-ray energies and intensities emitted in the decay of the nuclides ^{226}Ra, ^{227}Ac, ^{238}U, ^{240}Pu, and ^{241}Pu are presented in this supplement to IN-1448. For sake of completeness, data presented in the previous report are also given in the tables here. (auth)

54653 (CONF-720901-(Bks.1 and 2), pp 81-96) ENERGY-DEPENDENT CROSS SECTIONS IN THE THERMAL REGION. Leonard, B. R. Jr. (Battelle-Northwest, Richland, Wash.). 1972.

From Meeting on new developments in reactor physics and shielding calculations; Kiamesha Lake, NY. (12 Sep 1972).

The interpretation of neutron cross-section data in the thermal neutron energy region is complicated by many physical effects which are unique or intensified in this energy region. The problem which causes the greatest uncertainty in the interpretation of thermal cross sections is the inherent lack of information about the exact nature of the negative-energy resonances. This problem is most severe in the interpretation of fission and scattering cross sections because the limited number of exit channels require that amplitudes, rather than cross sections, be considered. Lack of attention to these coherent effects can lead to severe biases in the derived shapes and values. Simple continuum models of the negative-energy resonances can be used to derive expectation values of their contribution to the thermal cross sections and the uncertainty of that contribution can also be estimated. These considerations have been applied to the interpretation of cross section data for several heavy nuclei. The results of these considerations give estimates of the uncertainties in shapes and values which can be expected in the interpretations of the cross sections. In specific cases these considerations are of value in determining better estimates of the assignments of negative-energy levels and aid in selecting the most probable values from discrepant measurements. They also indicate that further accurate measurements of coherent scattering amplitudes for the fissile nuclei could lead to improved understanding of their cross sections. (auth)

54654 (CONF-720901-(Bks.1 and 2), pp 97-107) PREDICTING PRODUCTION RATES OF HEAVY ACTINIDES. Graves, W. E.; Benjamin, R. W. (Savannah River Lab., Aiken, S. C.). 1972.

From Meeting on new developments in reactor physics and shielding calculations; Kiamesha Lake, NY. (12 Sep 1972).

The prediction of reactor production and depletion rates for the heavy actinides is discussed. Some recent irradiation studies are briefly presented. An improved theoretical framework for making predictions is described. The current status of differential cross section data is surveyed. (J.W.R.)

54655 (CONF-720901-(Bks.1 and 2), pp 687-99) MEASUREMENTS OF DELAYED FISSION NEUTRON SPECTRA OF ^{235}U, ^{238}U, AND ^{239}Pu WITH PROTON RECOIL PROPORTIONAL COUNTERS. Fieg, G. (Kernforschungszentrum, Karlsruhe, Ger.). 1972.

From Meeting on new developments in reactor physics and shielding calculations; Kiamesha Lake, NY. (12 Sep 1972).

The delayed fission neutron spectra of U-235, U-238 and Pu-239 were measured for different time intervals after fission with proton recoil proportional counters. For these measurements, the spectra of the various time groups were determined. 14 MeV neutrons and, for U-235, also thermal neutrons were used to induce fission. Where published experimental group spectra were available, comparisons with these results were made. (auth)

54656 (COO-3058-21) LINEAR ACCELERATOR PROJECT PROGRESS REPORT, APRIL 1, 1972-JUNE 30, 1972. Gaerttner, Erwin R. (Rensselaer Polytechnic Inst., Troy, N. Y.). [nd]. Contract AT(11-1)-3058. 77p. Dep. NTIS.

GOLD-197 — neutron capture near 24.3 keV, pulse height spectra and relative cross section for, (E)
HELIUM — neutron total cross section at 0.7 to 30 MeV, (E)
INDIUM — neutron capture near 24.3 keV, pulse height spectra and relative cross section for, (E)
IRON — neutron total cross section at 22 to 25 keV, R-matrix fit to
LITHIUM-6 — neutron total cross section at 0.7 to 30 MeV, (E)
SODIUM — neutron emission time in assembly of
TANTALUM-181 — neutron capture near 24.3 keV, pulse height spectra and relative cross section for, (E)
URANIUM — neutron transmission and self-indication measurements in depleted
URANIUM-238 — neutron capture near 24.3 keV, pulse height spectra and relative cross section for, (E) (L.T.W.)

54657 (FEI-292) MEASUREMENTS OF NEUTRON CROSS SECTIONS OF RADIATION CAPTURE AND FISSION FOR SOME HEAVY NUCLEI BY THE METHOD OF TIME OF RETARDATION IN LEAD. Chelnokov, V. B.; Tolstikov, V. A.; Stavisskii, Yu. Ya.; Bergman, A. A.; Samsonov, A. E. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Obninsk. Fiziko-Energeticheskii Institut). 1971. 29p. (In Russian). Dep. NTIS (U. S. Sales Only).

A survey was made of cross section measurements of fissions of the nuclei ^{235}U and ^{239}Pu, the cross sections of radiation capture

of neutrons by the nuclei ^{107,109}Ag, ^{197}Au, ^{232}Th and ^{238}U and of the parameter $\alpha(E)$ for ^{239}Pu. These measurements had been made with a spectrometer on the moderation time in lead, with the special features of the method in view: absolute standardization of cross sections, energy resolution, and evaluation of the effect of resonance self-shielding. Comparisons of the data with those of other workers are made. (69 references) (auth)

54658 (JINR–P7-6523) NUCLEAR REACTIONS INDUCED BY XENON IONS AND EXPERIMENTS ON SUPERHEAVY ELEMENT SYNTHESIS. Flerov, G. N.; Oganesyan, Yu. Ts. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1972. 28p. (In Russian). Dep. NTIS (U. S. Sales Only).

A short review of experimental studies of the mechanism of complex nucleus interactions with the xenon ions is presented. The technique is described and the results of the first experiments on superheavy element synthesis are presented. The set up and the results of the fast experiments on the synthesis of superheavy elements are presented. (auth)

54659 (JINR–P15-6518) AVERAGE PROMPT NEUTRON NUMBER FOR SPONTANEOUS FISSION OF ^{256}Fm. Dakovskii, M.; Lazarev, Yu. A.; Oganesyan, Yu. Ts. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1972. 9p. (In Russian). Dep. NTIS (U. S. Sales Only).

The result of measurement of average prompt neutron number for spontaneous fission of ^{256}Fm is given: $\bar{\nu} = 3.73 \pm 0.18$ relative to $\bar{\nu}$ (^{244}Cm) = 2.69 ± 0.02. ^{256}Fm ($T_{\frac{1}{2}}$ = 2.6 hours) was synthesized using the inner beam of the U-300 cyclotron of the Laboratory of Nuclear Reactions (JINR). (auth)

54660 (RLO–2225-T-17-4) MEASUREMENT OF DELAYED NEUTRON ENERGY SPECTRA. Final Report. Woodruff, Gene L. (Washington Univ., Seattle. Dept. of Nuclear Engineering). Jul 1972. Contract AT(45-1)-2225. 12p. Dep. NTIS.

The equipment and techniques developed for the measurement of delayed neutron energy spectra are described. Some results for the thermal neutron fission of ^{235}U are reported. (J.W.R.)

54661 MOESSBAUER EFFECT IN ^{239}Pu. Gal, J. (Nuclear Research Center, Negev, Israel); Hadari, Z.; Bauminger, E. R.; Ofer, S. Phys. Lett.; 41B: No. 1, 53-4(4 Sep 1972).

The recoilless resonance absorption of the 57.3-keV γ-ray of ^{239}Pu was observed. The half-life of the 57.3-keV level was found to be 101 ± 5 ps. (auth)

54662 RADIATIVE CAPTURE OF ENERGETIC NEUTRONS BY ^{208}Pb. Bergqvist, I.; Drake, D. M.; McDaniels, D. K. (Los Alamos Scientific Lab., N. Mex.). Nucl. Phys.; A191: No. 3, 641-57(1972).

The radiative capture cross section of neutrons with energies covering the range 6.2 to 14.7 MeV has been measured for the ^{208}Pb(n,γ)^{209}Pb reaction. Gamma-ray spectra were recorded with a NaI(Tl) anti-Compton spectrometer. A time-of-flight technique was used to reject undesirable background. Absolute cross sections were determined for γ-ray transitions to the $g_{\frac{9}{2}}$ ground state, the $i_{\frac{11}{2}}$ state at 0.78 MeV, the doublet of $j_{\frac{15}{2}}$ and $d_{\frac{3}{2}}$ states near 1.5 MeV, and the close pair of $g_{\frac{7}{2}}$ and $d_{\frac{5}{2}}$ states at about 2.5 MeV in ^{209}Pb. All cross sections show a resonance behavior in accordance with the prediction of semi-direct capture theory as the neutron energy spans the giant-dipole resonance. The measured cross sections are a factor of 2–3 higher than the predicted values. (auth)

54663 TERMINATION OF THE R-PROCESS AND THE SYNTHESIS OF SUPERHEAVY ELEMENTS. Boleu, R. (Univ. of Lund, Sweden); Nilsson, S. G.; Sheline, R. K.; Takahashi, K. Phys. Lett.; 40B: No. 5, 517-21(7 Aug 1972).

Predictions for spontaneous and neutron-induced fission, alpha decay, and beta decay were made on the basis of potential-energy surfaces for $Z \geq 90$ nuclei on the neutron-rich side of the beta-stability line. In spite of their considerable quantitive uncertainties, these predictions appear to negate the possibility of superheavy element synthesis via a one- or two-step r process from supernovae. In addition, artificial superheavy element synthesis by two consecutive exploding nuclear devices appears improbable from these results. Neutron-induced fission seems to be even more decisive than spontaneous fission for the early termination of the r process. (auth)

54664 IDENTIFICATION OF A ROTATIONAL BAND IN THE ^{240}Pu FISSION ISOMER. Specht, H. J. (Univ., Munich); Weber, J.; Konecny, E.; Heunemann, D. Phys. Lett.; 41B: No. 1, 43-6 (4 Sep 1972).

Conversion electrons were measured preceding spontaneous fission of the 4-ns ^{240}Pu fission isomer. The more intense lines found are interpreted as components of three E2 transitions within a $K = 0^+$ rotational band. The large difference between the corresponding rotational constant $\hbar^2/2\theta = 3.33$ keV and that of the ^{240}Pu ground-state band (7.16 keV) strongly supports the hypothesis of shape isomerism. (auth)

54665 EXCITATION FUNCTION FOR THE ^{235}U(α,3n)^{236}Pu REACTION. Bethune, G. R.; Britt, H. C.; Erkkila, B. H. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., C; 6: No. 3, 1087-90(Sep 1972).

Cross sections were measured for the ^{235}U(α,3n)^{236}Pu, ^{235}U(α,t)^{236}Np, and ^{235}U(α,f) reactions at several α-particle bombarding energies between 24.5 and 28.0 MeV. (5 figures, 1 table) (auth)

54666 CALCULATIONS OF SPALLATION-FISSION COMPETITION IN THE REACTIONS OF PROTONS WITH HEAVY ELEMENTS AT ENERGIES ≤ 3 GeV. Hahn, R. L.; Bertini, H. W. (Oak Ridge National Lab., Tenn.). Phys. Rev., C; 6: No. 2, 660-9(Aug 1972).

The intranuclear-cascade codes recently discussed by Bertini were modified to include fission-spallation competition in the heavy elements during the evaporation phase of the reaction, and use an empirical, energy-independent relation for (Γ_n/Γ_f). Calculations of the reactions of protons with ^{238}U at several energies from 0.15 to 3.0 GeV, and with ^{235}U and ^{232}Th at 0.7 GeV, have been done to illustrate the results that are obtainable with these codes. The calculations do not allow any adjustment of parameters. However, the range of applicability of the calculations, especially their extension to nuclei (with $Z \lesssim 91$) that are not very fissionable, was investigated by means of the parameter Z_f, below which fission was taken to be relatively unimportant. A Z_f value of 91 was found to give results that agreed best with experimental data. In general, comparison with a large collection of experimental spallation yields, total fission cross sections, and particle multiplicities indicated that the calculations are able to reproduce the trends, and often the details, exhibited by the data. In the case of neutron multiplicities, only the calculations without fission effects agreed with the data, indicating that it is the energy available for evaporation, and not the fission competition, that influences neutron emission. (auth)

54667 INDEPENDENT YIELDS OF KRYPTON AND XENON ISOTOPES IN THERMAL-NEUTRON FISSION OF ^{235}U. OBSERVATION OF AN ODD–EVEN EFFECT IN THE ELEMENT YIELD DISTRIBUTION. Ehrenberg, B.; Amiel, S. (Soreq Nuclear Research Centre, Yavne, Israel). Phys. Rev., C; 6: No. 2, 618-28 (Aug 1972).

The fractional and independent fission yields of krypton isotopes (masses 87 to 94) and xenon isotopes (masses 137–143) produced in thermal-neutron fission of ^{235}U were measured using a mass separator operating in an on-line mode with a fission source exposed to time-controlled neutron fluxes. The noble-gas isotopes were collected simultaneously at given times and each mass was measured separately. The distribution of the isotopic yields of each element was found to be Gaussian, in general agreement with Wahl's estimates. The total independent yields of krypton and xenon, as well as their complementary elements, barium and strontium, were found to indicate an odd-even effect in the element yield distribution. Even-Z elements are formed in higher yields than their odd-Z neighbors (20–50% higher); the even-Z yields are also higher than Wahl's "normal" element yields (~12% higher for Kr and Ba and ~40% for Xe and Sr). Half-life values of 20 nuclides produced in the decay of krypton and xenon isotopes were measured as well. (auth)

54668 EFFECTIVE NEUTRON ABSORPTION CROSS SECTIONS FOR ^{252}Cf AND ^{253}Cf IN THE CENTRAL CHANNEL OF THE SM-2 REACTOR. Anufriev, V. A.; Gavrilov, V. D.; Zamyatnin, Yu. S.; Ivanenko, V. V.; Yakovlev, G. N. At. Energ. (USSR); 32: No. 6, 493-4(Jun 1972). (In Russian).

Two targets containing ^{252}Cf with admixtures of lighter Cf isotopes (~20%) were irradiated in the central channel of the CM-2 reactor for the purpose of determining the effective neutron absorption cross section. The burn-out cross section of ^{252}Cf was 72 ± 18 barns. The effective cross section for neutron absorption for ^{253}Cf was $6{,}260 \pm 1{,}800$ barns; its radiative capture cross section was about 10 barns. (K.S.W.)

54669 BLOCKING EFFECT IN URANIUM FISSION WITH 14-MeV NEUTRONS. Noelpp, U.; Abegg, R.; Schacher, J.; Wagner, R. (Univ., Basel). Helv. Phys. Acta; 45: 55-6 (1972). (In German).

A method for determining the lifetime of the compound nucleus in the (n,2nf) reaction is described. A UO_2 single crystal is oriented by proton blocking. Fission fragments are detected with glass detectors, and the tracks are etched and photographed. The lifetime of the compound nucleus can be determined from a pair of such photographs, taken for different angles between the incoming neutrons and the emitted fragments. (3 figures) (R.W.R.)

54670 SEARCH FOR TRACKS OF SPONTANEOUS FISSION FRAGMENTS FROM THE HEAVIER TRANSURANIUM ELEMENTS IN NATURALLY-OCCURRING MINERALS. Otgonsuren, O.; Perelygin, V. P.; Tret'yakova, S. P.; Vinogradov, Yu. A. At. Energ. (USSR); 32: No. 4, 344-7(Apr 1972). (In Russian).

Naturally occurring minerals and glasses characterized by various hydrothermal histories, such as pegmatite beds, quartz veins, and sulfide occurrences, were examined for the track density and length which would result from fission fragments by spontaneous fission of unstable nuclei. Such fission tracks in cavities on a quartz surface, for example, occurred in a density of 10^4 to 10^5 tracks/cm^2. The distribution of track length in quartz produced by spontaneous fission agreed well with that produced by induced (^{235}U + thermal neutrons) fission. (K.S.W.)

54671 SEARCH FOR (t,p) TRANSITIONS TO EXCITED 0^+ STATES IN THE ACTINIDE REGION. Casten, R. F. (Los Alamos Scientific Lab., N. Mex.); Flynn, E. R.; Garrett, J. D.; (and others). Phys. Lett.; 40B: No. 3, 333-7(10 Jul 1972).

The (t,p) reactions from ^{230,232}Th and ^{234,236,238}U were studied at 15–20 MeV bombarding energy. The known excited 0^+ states in ^{232}Th, ^{236,238}U were not observed nor was any excited 0^+ strength located in ^{234}Th or ^{234}U. The previously reported strong L = 0 (p,t) transitions in this region as well as the weak L = 0 (t,p) strengths reported here constitute a strong indication of the existence of quadrupole pairing correlations in deformed superfluid nuclei. (auth)

54672 PRODUCTION OF ACTINIDES AND THE SEARCH FOR SUPER-HEAVY ELEMENTS USING SECONDARY REACTIONS INDUCED BY GeV PROTONS. Unik, J. P.; Horwitz, E. P.; Wolf, K. L.; (and others) (Argonne National Lab., Ill.). Nucl. Phys.; A191: No. 2, 233-44(1972).

A search for actinide and super-heavy elements produced by means of secondary reactions during the irradiation of tungsten and uranium targets with 12 and 28 GeV protons has been made. Yields for production of many actinide isotopes in uranium targets are given up to and including ^{248}Cf. Upper limits have also been established for spontaneous fission activities which could be attributed to the decay of possible super-heavy elements produced by means of secondary reactions. (auth)

54673 DECAY OF ^{227}Th FROM $\alpha-\gamma$ COINCIDENCE AND DIRECTIONAL CORRELATION STUDIES. Hesselink, W. H. A.; Wapstra, A. H.; Kromme, J. G. (and others) (Univ. of Tech., Delft, Netherlands). Nucl. Phys.; A191: No. 2, 294-304(1972).

Using ^{227}Th sources obtained by evaporation of the activity onto Al foils, $\alpha-\gamma$ coincidences and $\alpha-\gamma$ directional correlations have been measured employing Ge(Li) and silicon surface-barrier detectors. A decoupling experiment using a superconductive magnet of 1.5 Tesla has been carried out to investigate the attenuation of the $\alpha-\gamma$ directional correlations due to extranuclear effects. Of the about 100 γ-rays observed (20 of them for the first time), all but 6 have been placed in a decay scheme. The directional correlation data have led to several new spin assignments and to the confirmation of earlier tentative assignments. The relative α-particle intensities and the $\alpha-\gamma$ directional correlation results show that the L = 2 intensities in the favored α-decay to the different levels of the $^3/_2^+$ [631] band are uncommonly weak, indicating a limitation to the applicability of the Nilsson model at low excitation energy. (auth)

54674 EMISSION OF THE ^{5}He IN THE SPONTANEOUS FISSION OF ^{252}Cf. Cheifetz, E. (Weizmann Inst. of Science, Rehovot, Israel); Eylon, B.; Fraenkel, E. Gavron, A. Phys. Rev. Lett.; 29: No. 12, 805-8(18 Sep 1972).

The emission of ^{5}He($T_{\frac{1}{2}} = 8 \times 10^{-22}$ s for decay into α + n) in spontaneous fission of ^{252}Cf is established from a correlation measurement involving the direction and the kinetic energies of the neutrons and the long-range α particles. Approximately 11% of these α's are products of ^{5}He breakup. The initial energy of the fragments and of the ^{5}He at scission are calculated from the properties of the ^{5}He decay. They are 31 ± 11 and 3.2 ± 0.9 MeV, respectively. (auth)

Nuclear Theory

Refer also to abstracts 54238, 54382, 54600, 55061, 55063, and 55077.

54675 (BNL–17029) RADIATIVE DECAY OF NEUTRON–RESONANT STATES. Chrien, R. E. (Brookhaven National Lab., Upton, N. Y.). 1972. 30p. (CONF-720701–2). Dep. NTIS.

From Conference on nuclear structure studies with neutrons; Budapest, Hungary (29 Jul 1972).

Ways in which neutrons are employed to investigate the radiative decay of highly-excited nuclear states are discussed. Neutron capture γ-rays are useful for spin and parity assignments for such states, as well as providing some insight into the capture reaction mechanism. Recent capture γ-ray experiments and threshold photoneutron studies bear on the distribution of radiative strength with excitation energy. Intermediate structure in photon strength functions leads to an interpretation in which doorway states play an important role. Recent experiments relative to these topics are described. (auth)

54676 (CONF-720901–(Bks,1 and 2), pp 1087-1106) FISSION CROSS SECTIONS AND THE FISSION PROCESS. Michaudon, Andre (CEN de Saclay, Gif-sur-Yvette, France). 1972.

From Meeting on new developments in reactor physics and shielding calculations; Kiamesha Lake, NY. (12 Sep 1972).

The Strutinsky prescription for fission barrier calculations is discussed. This new method for more accurate calculations of the fission barriers, taking into account the effect of shells at all deformations, has provided a better understanding of the fission process. Puzzling experimental results, such as fission isomers and intermediate structure, that remained previously unexplained with conventional models, could then be interpreted in terms of double-humped barrier shapes. This is quite important for the understanding and for the predictions of the fission cross sections. Near threshold, vibrational fission resonances can appear; below threshold, intermediate structure can exist and influence the fission cross section for thermal neutrons; the intermediate structure effect can also be present, though weaker, in the fission cross section of fissile nuclei. (auth)

54677 (CONF-720701–3) OPTICAL MODEL. Satchler, G. R.; Perey, F. G. (Oak Ridge National Lab., Tenn.). [nd]. 56p. Dep. NTIS.

From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

Recent applications of the optical model (the local version, except in one case) to various measurements involving neutrons are reviewed. (W.D.M.)

54678 (COO–535–672) REMARKS ON ABSORPTIVE POTENTIALS AND HEAVY ION ELASTIC SCATTERING. Rickertsen, L. D. (Colorado Univ., Boulder. Nuclear Physics Lab.). [nd]. 10p. Dep. NTIS.

The nature of the gross structure in the optical model analysis of heavy ion elastic scattering is investigated. Further, the success of the double-resonance effect in reproducing intermediate structure is studied. (auth)

54679 (COO–3001–17) MAGNETIC MOMENTS OF ODD MASS NUCLEI WITH SIMPLE CONFIGURATIONS. Arima, Akito; Huang-Lin, Lih Jen (State Univ. of New York, Stony Brook. Dept. of Physics). 1972. 13p. Dep. NTIS.

Results of calculations for magnetic moments of odd A nuclei using simple shell model configurations are presented. The effects of core polarization and the mesonic current were accounted for First order perturbation theory was used to estimate the deviation due to core polarization. It was found that while in sum cases the sum of the two corrections is desirable, the two mechanisms strongly cancel in the magnetic moments of $j = l + \frac{1}{2}$. Also some recently measured magnetic moments in the A = 208 region are not explained if the mesonic correction is taken into account. (J.W.R.)

54680 (COO–3071–7) SIMPLIFIED MICROSCOPIC MODEL OF THE CORIOLIS ANTI-PAIRING TRANSITION. Vallieres, Michel; Klein, Abraham; Dreizler, R. M. (Pennsylvania Univ., Philadelphia. Dept. of Physics). 12 Jun 1972. Contract AT(11-1)-3071. 16p. Dep. NTIS.

The pairing plus quadrupole–quadrupole interaction is studied for a single j level by a sum rule method ("current algebra") in the regime where the "nucleus" is deformed. The ground state rotational band is shown to undergo the Coriolis anti-pairing transition. (auth)

54681 (COO–3071–9) ALGEBRAIC APPROACH TO THE THEORY OF COLLECTIVE MOTION: SPHERICAL TO DEFORMED TRANSITION IN THE SINGLE-j SHELL. Vallieres, Michel; Klein, Abraham; Dreizler, R. M. (Pennsylvania Univ., Philadelphia. Dept. of Physics). 20 Jul 1972. 55p. Dep. NTIS.

The program of the algebraic approach to nuclear collective motion is summarized. In essence, it should permit an accurate solution of the many-body problem within a subspace of the many particle space if the conditions defining collective motion are present. The formulation, containing both dynamical and kinematical aspects, leads to coupled non-linear algebraic equations for the matrix elements between collective states of fermion pair operators. An explicit set of equations is given for the problem

of N (even) particles confirmed to a single-j-shell and described by the conventional pairing plus quadrupole–quadrupole interaction Hamiltonian. This formulation is designed to be nearly exact in the pairing dominant (seniority) limit and to be accurate enough (based on plausibility arguments) to describe the transition from spherical to deformed shape. That this is so is verified for configurations—the largest being $j^N = (21/2)^6$—for which exact solutions are available. The present method can be viewed as an angular momentum conserving alternative to the description of the transition based on the Hartree–Bogoliubov-BCS method. Qualitative and detailed comparisons of the two methods are carried out. In particular, it is shown from approximate analytic results that the two theories predict the transition to occur for almost identical values of the parameters. Overall agreement with exact results is much better for the algebraic method, however, confirming its status as an approximate method of variation after projection. (auth)

54682 (COO-3071-10) CONCEPT OF TRANSITION OPERATOR BOSON AND ITS APPLICATION TO AN EXACTLY SOLUBLE MODEL. Dreizler, R. M.; Klein, Abraham (Pennsylvania Univ., Philadelphia. Dept. of Physics). 5 Jul 1972. 34p. Dep. NTIS.

In phenomenological descriptions of nuclear vibrations a close connection is implied or expressed between the most collective transition operator and the harmonic oscillator (boson) variables which are introduced to describe the collective motion. With the help of a widely used example—the monopole vibration model of Meshkov, Lipkin, and Glick—it is shown how this relationship suggests, for the microscopic case, a new and flexible class of boson representations. As shown, these are capable of yielding accurate descriptions of the system, not only in the extremes of weak and strong coupling, but also in the usually more inaccessible intermediate regions as well. (6 figures, 3 tables) (auth)

54683 (FRNC-TH-180) REALISTIC NONLOCAL FORCES AND THEIR IMPORTANCE IN UNDERSTANDING THE MICROSCOPIC PROPERTIES OF NUCLEAR MATTER AND NUCLEI. Hammann, T. F. (Strasbourg Univ. (France)). 1970. 120p. (In French).

Thesis.

A realistic potential which is separable and nonlocal and takes into consideration phase shifts in the S, P and D waves up to 400 MeV is presented. The discrepancies between the calculated and the experimental phase shift curves are of the same order of magnitude as the experimental errors. This potential is without short-range singularity and sufficiently uniform to ensure an adequate convergence in the perturbation series. The potential gives a binding energy of −15.5 MeV (1st-order approximation) per particle at the saturation density (1.45 fm^{-1}), which is in agreement with experiment. When a second-order approximation is used, the agreement disappears, a considerably larger binding energy being obtained which is of the same order of magnitude as that obtained using the G reaction matrix. This potential enables the negative-parity spectra of ^{4}He to be explained. The ^{18}O, ^{19}O, and ^{20}O levels calculated in the framework of classical shell model with this potential and the reaction matrix deduced from the Hartree–Fock potential compare quite well with experiment, except in the case of ^{20}O, where the model used is less accurate. The spectra of nuclei in the A = 50 region were studied. In the case of ^{50}Sc, it is shown that the inclusion of the most probable 1 particle–hole configurations is equivalent to the 3 particle–1 hole perturbation correction. (France)

54684 (IAE-2115) STUDY OF SOME PROPERTIES OF STRUTINSKII'S "METHOD OF SHELL CORRECTION." Pik-Pichak, G. A.; Grechukhin, D. P. (Institut Atomnoi Energii, Moscow (USSR)). 1971. 36p. (In Russian). Dep. NTIS (U.S. Sales Only).

Various properties of the "shell correction method" were investigated on the basis of S. G. Nilsson's model (1955). A shell correction proved to be very sensitive to a scheme of single-particle states. If a "realistic" scheme of levels arises from Nilsson's scheme through a shift of one of several levels, then the shell correction method ceases to be applicable. Averaging the nuclear masses, as is done for the determination of parameters for the drop model, and averaging according to single-particle states in the shell correction method, both lead to means which differ by 3 to 4 MeV. (tr-auth)

54685 (INP-795) INTERMEDIATE COUPLING APPROACH IN THE UNIFIED MODEL OF THE ^{39}K NUCLEUS. Wiktor, S. (Institute of Nuclear Physics, Krakow (Poland)). Mar 1972. 16p. Dep. NTIS (U. S. Sales Only).

The low energy levels of the ^{39}K nucleus are examined in the framework of the intermediate coupling model in which the $(d_{\frac{3}{2}})^{-1}$ proton hole is assumed to couple to the 2^+, 3^- and 5^- core states of the doubly magic ^{40}Ca nucleus. Comments concerning the parameters are made. In particular the coupling strength parameters are related to the dynamical deformation parameters obtained in coupled channels analysis of the inelastic scattering processes. (auth)

54686 (INR-1406) FRACTIONAL PARENTAGE COEFFICIENTS FOR $j = 1\frac{1}{2}$ ORBITAL. Kerek, A.; Kownacki, Jan (Institute of Nuclear Research, Warsaw (Poland)). 1972. 6p. Dep. NTIS (U.S. Sales Only).

The normalized sets of the fractional parentage coefficients $[j^2(J_1)jJ\,|\,j^3\,VJ]$ for $(j = 1\frac{1}{2})^3$ configuration in j–j coupling are calculated. (auth)

54687 (ISS-71/29) INVESTIGATION OF SHORT-RANGE CORRELATIONS IN NUCLEI BY MEANS OF HIGH ENERGY ELECTRON SCATTERING. Ciofi Degli Atti, C. (Istituto Superiore di Sanita, Rome (Italy). Laboratori di Fisica). 8 Oct 1971. 19p. (CONF-710911-15). Dep. NTIS (U. S. Sales Only).

From fourth international conference on high energy physics and nuclear structure; Dubna, USSR (7 Sep 1971).

The present status of the study of short-range correlations in nuclei by means of high energy electron scattering is briefly reviewed. Particular attention is devoted to the recently discussed problem of the effects of Brueckner and Jastrow correlations on the charge form factor of light nuclei. (auth)

54688 (ITF-71-77-P) PRESENT-DAY PROBLEMS OF THE THEORY OF NUCLEAR FORCES. Babikov, V. V.; Pak Ben Gir (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1971. 17p. (In Russian). Dep. NTIS (U. S. Sales Only).

Brief discussion is presented on the following present-day problems of the theory of nuclear forces: the relativistic description of the two-nucleon interaction, the coupling of channels, and many-particle effects. (auth)

54689 (ITF-72-12-P) VIBRATIONS OF A FERMI-FLUID DROP AND THE GIANT RESONANCE IN INTERMEDIATE AND HEAVY NUCLEI. Akhiezeri, I. A.; Barts, B. I.; Lazurik-El'tsufin, V. T. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1972. 14p. (In Russian). Dep. NTIS (U. S. Sales Only).

The giant resonance in nuclear reactions with the participation of intermediate and heavy nuclei is considered in the model of a Fermi-fluid drop. Both the purely nuclear and electric interactions of nucleons are taken into account. This model enables one to describe the experimentally observed position of a giant dipole resonance in photonuclear reactions in a great number of particles. In particular, it is possible to account for the slower decrease in resonance energy with increasing A than that according to the law $A^{-\frac{1}{3}}$ for a fluid. A number of experimental points do not fit the curve corresponding to the excitations of dipole vibrations, but come near the estimated curves corresponding to l = 0 and l = 2. It should be of great interest, therefore, to experimentally determine the multipolarity appropriate levels. (auth)

54690 (ITF-72-57-P) HIGH-ENERGY APPROXIMATION AND THE GENERALIZED HUYGEN'S PRINCIPLE. Sitenko, A. G.; Peresypkin, V. V. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1972. 14p. (In Russian). Dep. NTIS (U. S. Sales Only).

The solution of the Lippman–Schwinger equation was investigated within the framework of high-energy approximation. It is proved that the solution of the Lippman–Schwinger equation in the high-energy approximation satisfies the generalized Huygen's principle used in the diffraction theory nuclear processes. The diffraction emission is considered in the interaction of charged hadrons one with another and the nuclei. (auth)

54691 (JINR-P2-6539) ON THE CALCULATION OF ABSORPTION IN NEUTRAL PION COHERENT PHOTOPRODUCTION ON NUCLEI. Pak, A. S.; Tarasov, A. V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1972. 8p. (In Russian). Dep. NTIS (U. S. Sales Only).

The more accurate calculation of the absorption in process of neutral pion coherent photoproduction on nuclei is shown to allow the removal of the discrepancy between the upper boundary of the module square of the spin independent part of the amplitude of the $\gamma N \to \pi^0 N$ process and the value of this quantity obtained from the experimental data analysis according to theoretical formulas. (auth)

54692 (JINR-P4-6543) FOR A BASING OF A CRANKING-MODEL. Dzholos, R. V.; Kartavenko, V. G. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1972. 15p. (In Russian). Dep. NTIS (U. S. Sales Only).

The dynamic variables, which are parameters of a symmetry group of a Hamiltonian of a fermion system, have been selected using a finite boson representation of fermion operators and

Bogolubov's transformation in a theory of a strong coupling. The obtained Hamiltonian is handy for describing nuclear rotational motion both when an average field is axial symmetric and when it's not. In the case of an axial symmetry this Hamiltonian is equal to a cranking-model Hamiltonian. (auth)

54693 (LA-DC-72-954) NUCLEAR WAVE FUNCTIONS FROM PARTICLE TRANSFER DATA. Kisslinger, Leonard S. (Carnegie-Mellon Univ., Pittsburgh, Pa. Los Alamos Scientific Lab., N. Mex.). [nd]. 11p. (CONF-720819-6). Dep. NTIS.

From International conference on few particle problems in nuclear interactions; Los Angeles, CA. (28 Aug 1972).

The extraction of information on the particle structure of nuclei from particle transfer reactions is discussed. An approach which uses improved representations of the scattering amplitude in order to include cut corrections is described. The application of the method to low energy nuclear physics for the calculation of spectroscopic factors and its extension to high energy to determine high momentum components of nuclear wave functions is illustrated. (J.W.R.)

54694 (LBL-972) COMMON FEATURES AND DIFFERENCES BETWEEN FISSION AND HEAVY ION PHYSICS. Swiatecki, W. J. (California Univ., Berkeley. Lawrence Berkeley Lab.). Jun 1972. Contract W-7405-eng-48. 14p. (CONF-720634-1). Dep. NTIS.

From first topical European nuclear physics conference; Aix-en-Provence, France (26 Jun 1972).

The macroscopic approach to fission and fusion physics is formulated. A minimum set of three degrees of freedom is described qualitatively. The gross features of the potential energy in this configuration space are discussed. The problem of nuclear viscosity is mentioned and comparisons with liquid ^{3}He are made. Some effects of large angular momenta are described. (auth)

54695 (LYCEN-7213) DWBA ANALYSIS OF SUB-COULOMB MULTI-TRANSFER REACTIONS. El Baz, E.; Meyer, J.; Nahabetian, R.; Pigeon, J. (Lyon Univ. (France). Institut de Physique Nucleaire). Feb 1972. 19p. Dep. NTIS (U. S. Sales Only).

The DWBA analysis of the heavy-ion-induced transfer reaction is usually made by approximating the recoil effect. Its validity is based on the fact that the mass of the transferred particle is small compared to the mass of the cores. A method allowing an exact treatment is proposed, and the only change comes from the radial integral which becomes a two-fold integral while the geometrical part is easily expressed in a graphical manner. (France)

54696 (ORNL-TM-3951) DEFORMED RENORMALIZED BRUECKNER-HARTREE-FOCK APPROXIMATION AND ITS APPLICATION TO ^{12}C. Becker, Richard L.; Braley, R. C.; Ford, W. F.; Patterson, M. R. (Oak Ridge National Lab., Tenn.). Sep 1972. Contract W-7405-eng-26. 12p. Dep. NTIS.

The renormalized Brueckner-Hartree-Fock theory is generalized to permit calculation of deformed intrinsic states with realistic nuclear forces. In ^{12}C the Hamada-Johnston interaction gives nearly large enough deformations and good binding, size, and intrinsic separation energies. Angular momentum projection from the oblate state yields moments, B(EL)'s, and electron scattering form factors with big enhancements over rigid rotor values, and substantiates that the 14.1 MeV, 4^+ state is rotational without requiring such a large intrinsic hexadecapole moment. (auth)

54697 (ORO-4317-7) SENSITIVITY OF LOW-ENERGY 3-BODY PROPERTIES TO THE OFF-SHELL 2-BODY t-MATRIX. Technical Report No. 72-121. Lavine, J. P.; Mukhopadhyay, S. K.; Stephenson, G. J. Jr. (Maryland Univ., College Park. Dept. of Physics and Astronomy). 1972. 18p. Dep. NTIS.

Direct modifications are made to the off-shell two-body t-matrices which are used as input to the Faddeev-Lovelace equations for the three-body bound state and for scattering below breakup. The t-matrices are modified when either momentum argument exceeds a particular value, in a manner consistent with off-shell unitarity. In this way, it is possible to test the dependence of these three-body properties on different regions of the off-shell momenta. A strong sensitivity for both momenta less than 2 f^{-1}, weak, potential dependent sensitivity when either argument is between 2 and 5 f^{-1}, and essentially no dependence if either argument exceeds 5 f^{-1} was found. (auth)

54698 (ORO-4317-8) GEL'FAND-LEVITAN-UNITARY-TRANSFORM FORMALISM FOR DIRECT EXTENSION OF THE TWO-NUCLEON T MATRIX OFF THE ENERGY SHELL. Technical Report No. 73-001. Picker, H. S.; Lavine, J. P (Maryland Univ., College Park. Dept. of Physics and Astronomy). 1972. 28p. Dep. NTIS.

The unitary-transform method of Coester et al. is modified, for uncoupled partial waves in which there are no bound states, so that empirical phase shifts rather than a potential fitted to them may be used as the basic input. This is accomplished by invoking the Gel'fand-Levitan inverse scattering formalism to generate a complete orthonormal set of scattering wave functions from the phase shifts. The result is a convenient formal framework for analyzing the uncertainties in the off-energy-shell behavior of the two-nucleon interaction. Variations in the off-energy-shell T matrix arising from changes in the phase shifts, as well as those due to different short-range nonlocalities, may be studied directly using the method presented here. (auth)

54699 (ORO-4317-11) (p,2p) REACTIONS WITH DIVERS POTENTIALS. Technical Report No. 73-002. Stephenson, G. J. Jr.; Redish, Edward F.; Lerner, Gerald M.; Haftel, M. I. (Maryland Univ., College Park. Dept. of Physics and Astronomy). 1972. 20p. Dep. NTIS.

The p-p cross sections relevant to a factorized impulse approximation treatment of (p,2p) reactions from 150 MeV to 350 MeV were calculated. Several on-shell prescriptions were used and compared with the half-off-shell prescription suggested by the Faddeev-Watson multiple scattering series. Four phenomenological potentials, Hamada-Johnston, Bryan-Scott III, Reid Hard Core, and Reid Soft Core, were investigated as well as three potentials which are phase-shift equivalent to the Reid Soft Core potential. Significant differences were found between the various prescriptions for all of the potentials. A wide range was also observed in the predictions of the various phenomenological potentials for each prescription. However, the ratio of the half-shell cross section to the on-shell cross section is remarkably insensitive to the choice of potential, especially where the half shell prescription is needed. This suggests a simple method for extrapolating from the elastic scattering data to the appropriate half-shell cross section. (auth)

54700 (RT/FI-(72)6) FAST NEUTRON RADIATIVE CAPTURE CROSS SECTIONS OF STABLE NUCLEI WITH $29 \leq Z \leq 79$. Benzi, V.; D'Orazi, R.; Reffo, G.; Vaccari, M. (Comitato Nazionale per l'Energie Nucleare, Rome (Italy)). 22 Feb 1972. 335p. Dep. NTIS (U.S. Sales Only).

The results of a semi-empirical estimate of fast neutron radiative capture cross sections of all stable nuclei with $29 \leq Z \leq 79$ in the energy range 1 keV to 10 MeV are given in this report. The calculations were carried out on the basis of the Hauser-Feshbach-Margolis statistical model; direct and collective capture and $(n,2\gamma)$ process were also taken into account by means of simplified models. (auth)

54701 (RT/FI-(72)7) MARE: A FORTRAN IV CODE FOR COMPOUND NUCLEUS REACTION CALCULATIONS IN THE CONTINUUM. Reffo, G.; Vaccari, M. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 20 Mar 1972. 53p. Dep. NTIS (U. S. Sales Only).

The physical model and the FORTRAN IV program for compound nucleus reaction calculations in the continuum are described in this report. The adopted model takes into account up to three particle emissions and γ rays deexcitation is considered as a process competing with the evaporation of particles (neutrons, protons, alpha particles). (auth)

54702 RELATIONS AMONG MAGNETIC MOMENTS AND M1 RATES IN SINGLE-CLOSED-SHELL NUCLEI. Nomura, M. (Tokyo Univ.). Phys. Lett.; 40B: No. 5, 522-4(7 Aug 1972).

Under the assumption that the effective magnetic moment operator is expressed in terms of one- and two-body operators which are not explicitly specified, relations among magnetic moments and M1 rates in single-closed-shell nuclei are studied. (auth)

54703 MOESSBAUER TRANSMISSION AND SCATTERING FOR ARBITRARY POLARIZATIONS. Chrisman, B. L. (Univ. of Illinois, Urbana). Nucl. Phys.; A186: No. 2, 264-72(1972).

Polarization effects in Mössbauer experiments are discussed using an S-matrix and density-matrix formalism. Equations are derived for both Mössbauer transmission and scattering. The generality of the formalism is demonstrated by extending the discussion to include interference between Mössbauer and electronic scattering. (auth)

54704 NUCLEAR DENSITIES IN A MODEL WELL OF ARBITRARY SHAPE. Bonche, P. (CEN, Saclay, Gif-sur-Yvette, France). Nucl. Phys.; A191: No. 3, 609-26(1972).

A method of calculation of the nuclear densities of deformed heavy nuclei is proposed. The density is expressed in terms of the Green function which is replaced by its multiple reflection expansion. The contribution to the density of the first terms of this expansion is given. The method is tested in the case of an

infinite spherical square well for which the exact calculation is elementary. The agreement gives confidence in the proposed approximation for the densities of deformed heavy nuclei. (auth)

54705 INCOMING WAVE BOUNDARY CONDITION FOR ELASTIC SCATTERING OF HEAVY PARTICLES AT INCIDENT ENERGIES NEAR THE COUPLOMB BARRIER. Eisen, Y.; Vager, Z. (Weizmann Inst. of Science, Rehovot, Israel). Nucl. Phys.; A187: No. 1, 219-24(1972).

An incoming wave boundary condition (IWB) approach is used to calculate differential cross sections for ^{16}O + Ca and α + Pb elastic scattering, at incident energies near the Coulomb barrier. A comparison is made to optical model (OM) calculations and it is shown that the present method is competitive with the OM method in the energy region mentioned above. (auth)

54706 DWBA TREATMENT OF CLUSTER TRANSFER REACTIONS. Kubo, K.-I. (Tokyo Univ.); Hirata, M. Nucl. Phys.; A187: No. 1, 186-204(1972).

The cluster transfer reaction (^{6}Li,d), (^{7}Li,t), (^{3}He,^{7}Be) etc., are investigated in the framework of DWBA with a finite-range interaction. It is proposed how to determine the available wave functions of Li and Be, and the effective interaction that causes the transfer reaction. An additional approximation is discussed to simplify the numerical calculation. The validity of DWBA is tested by a comparison of the results of numerical calculations of the processes (^{6}Li,d) and (^{7}Li,t) with experiment. (auth)

54707 KNOCK-ON MECHANISM FOR (n,α) REACTIONS INDUCED BY FAST NEUTRONS ON THE DEFORMED DOUBLY EVEN NUCLEI. Kozlowski, M.; Glowacka, L.; Jaskola, M.; (and others) (Univ., Warsaw Inst. of Nuclear Research, Warsaw). Nucl. Phys.; A187: No. 1, 177-85(1972).

A method for the calculation of the energy distribution of α-particles from the (n,α) reaction on deformed doubly even nuclei is developed. The Feynman triangular diagram is used for the calculation. The resulting energy distributions for the 14-MeV (n,α) reactions in ^{160}Dy, ^{162}Dy, ^{164}Dy, ^{166}Er and ^{168}Er are compared with the experimental data. The agreement suggests the dominance of the knock-on mechanism in the investigated reactions. (auth)

54708 FINITE-RANGE DWBA ANALYSES OF THE $^{16}O(^7Li,t)^{20}Ne$ AND $^{15}N(^7Li,t)^{19}F$ REACTIONS. Kubo, K.-I. (Tokyo Univ.). Nucl. Phys.; A187: No. 1, 205-18(1972).

The reactions $^{16}O(^7Li,t)^{20}Ne$ and $^{15}N(^7Li,t)^{19}F$ at $E_{^7Li} = 15$ MeV, are analyzed theoretically by the DWBA method with a finite-range interaction. On basis of the weak coupling model for the nuclear structure, the differential cross sections are calculated, and the validity of this model is tested by comparing with experimental data. The spectroscopic factors for 4p-0h states are extracted. (auth)

54709 LIMITATION ON THE USE OF IMPULSE APPROXIMATION IN NUCLEAR β-DECAY. Armstrong, L. Jr.; Kim, C. W. (Johns Hopkins Univ., Baltimore). Phys. Lett.; 41B: No. 1, 39-42(4 Sep 1972).

Nuclear β-decay processes are considered using two techniques: the usual impulse approximation and the elementary-particles treatment. Both methods of calculation are shown to lead to essentially equivalent numerical results for allowed transitions ($\Delta J^{P_i P_f} = 0^+,1^+$) and for forbidden transitions of the types $\Delta J^{P_i P_f} = 1^-$ and possibly $2^+,3^-,\ldots$. For forbidden transitions of the types, $\Delta J^{P_i P_f} = 0^-,2^-,3^+,\ldots$, the two methods may lead to inequivalent results. This discrepancy may be due to neglect of meson-exchange effects in the impulse approximation. (auth)

54710 EXTENSION OF THE VARIABLE MOMENT OF INERTIA MODEL TO ODD-EVEN NUCLEI. Volkov, A. B. (McMaster Univ., Hamilton, Ont.). Phys. Lett.; 41B: No. 1, 1-3(4 Sep 1972).

The variable-moment-of-inertia model is shown to be applicable to odd–even nuclei when Coriolis-coupling effects are small. Under appropriate circumstances the odd–even moments of inertia should be nearly equal to those of an adjoining even–even nucleus. (auth)

54711 FORWARD DISPERSION RELATIONS AND LOW-ENERGY ELASTIC SCATTERING OF CHARGED PARTICLES FROM NUCLEI. Viollier, R. D.; Plattner, G. R.; Trautmann, D.; Alder, K. (Univ., Basel). Phys. Lett.; 40B: No. 6, 625-7(21 Aug 1972).

A forward dispersion relation for charged-particle scattering from nuclei is deduced. Inclusion of the Coulomb interaction leads to a simple modification of the formalism for uncharged projectiles. The modified forward dispersion relation is applied to p–α scattering below 50 MeV. (auth)

54712 PHENOMENOLOGICAL DESCRIPTION OF THE NUCLEAR ROTATIONAL STATES. Stockmann, M. I.; Zelevinsky, V. G. (Inst. of Nuclear Physics, Novosibirsk, USSR). Phys. Lett.; 41B: No. 1, 19-22(4 Sep 1972).

General properties of a class of phenomenological models generalizing the VMI model are considered, as well as their applicability to the numerical description of the ground-state bands and possible relation to the microscopic theory. (auth)

54713 ELECTROMAGNETIC CORRECTIONS OF ORDER $Z\alpha^2$ AND $Z^2\alpha^3$ TO FERMI β-DECAYS. Jaus, W. (Univ., Zurich). Phys. Lett.; 40B: No. 6, 616-21(21 Aug 1972).

Electromagnetic corrections of order $Z\alpha^2$ and $Z^2\alpha^3$ to pure Fermi decays are discussed and used to calculate the effective ft values of seven $0^+ \rightarrow 0^+$ β transitions. These fall into two groups which differ by about 1.5%. (auth)

54714 DAMPING OF HOLE STATES IN THE GIANT DIPOLE RESONANCE. Kabachnik, N. M.; Sagina, I. P. (Inst. of Nuclear Physics, Moscow). Phys. Lett.; 41B: No. 1, 31-3(4 Sep 1972).

Widths of hole states can be naturally included in the particle–hole calculation scheme if the factorization method is employed. (auth)

54715 APPLICATION OF THE METHOD OF MOMENTS TO THREE-BODY SCATTERING. Harms, E. (Fairfield Univ., Conn.). Phys. Lett.; 41B: No. 1, 26-8(4 Sep 1972).

The method of moments is investigated as a possible iterative method of solution of the Faddeev equations. The method is shown to converge rapidly to the three-body wave function for the case of zero-energy neutrons scattering off deuterium. It is suggested that the method should be appropriate for the treatment of three-body break-up with separable or local potentials. (auth)

54716 TRIANGLE GRAPHS AND ISOSPIN VIOLATION IN 3-PARTICLE FINAL-STATE REACTIONS. Beam, J. E.; Valkovic, V. (Rice Univ., Houston, Tex.). Phys. Lett.; 41B: No. 1, 13-15 (4 Sep 1972).

The rescattering process for a 3-particle final-state reaction represented by a triangle diagram should lead to isospin violation. This effect is due to the possibility of kinematically selecting one triangle-graph rescattering process in favor of its charge conjugate. (auth)

54717 INTERMEDIATE-STATE, SINGLE-PARTICLE ENERGIES IN MANY-FERMION ENERGY CALCULATIONS. Baker, George A. Jr. (Brookhaven National Lab., Upton, N. Y. Cornell Univ., Ithaca, N. Y.); Gammel, John L. Phys. Rev., C; 6: No. 2, 403-7(Aug 1972).

It is shown that the naive solution of the two-hole-line-approximation equations for the many-fermion ground-state energy leads to physically incorrect results. As poles cross the integration contour, residue corrections must be appended to the equations. Unfortunately, the corrected equations do not appear to be solvable for nuclear-type potentials. (auth)

54718 APPROACH TO THE NUCLEAR MANY-BODY PROBLEM BY VARIATIONALLY DETERMINED TRANSFORMATION. II. Mann, A. (Hebrew Univ., Jerusalem. Indiana Univ., Bloomington); Unna, I.; Gross, R. Phys. Rev., C; 6: No. 2, 415-25(Aug 1972).

A generalization of the Hartree–Fock (HF) method incorporating two-body correlations is presented. The correlations are introduced by means of a unitary operator e^{iF}, where F is a Hermitian one- and two-body operator to be determined by the variational principle. Assuming that the matrix elements of F are small so that powers of F higher than the second may be neglected, a set of linear equations determining F is obtained. The relation between the method and methods used to treat singular interactions is discussed. The method is applied to two recently suggested models and is compared with the HF method, second-order perturbation theory, and with the random-phase approximation. It is found that the method yields very good results within the range of validity of the approximations, which seems to call forth applications to more realistic problems. Possible applications to the study of collective phenomena in nuclei are indicated. (auth)

54719 IRROTATIONAL OR ROTATIONAL FLOW MOTION IN DEFORMED NUCLEI. Gupta, Raj K. (International Centre for Theoretical Physics, Trieste, Italy). Phys. Rev., C; 6: No. 2, 426-35(Aug 1972).

The "governor model" of Trainor and the author, based on the assumptions of a rotational flow motion and the existence of a rotationally invariant core in nuclei, is completely reformulated in terms of the better-known deformation parameter β_0. It is shown that this model results in an expression for the ground-state moment of inertia which, in agreement with the empirical study of Mariscotti et al. (the variable-moment-of-inertia model), gives a linear dependence on the deformation parameter ($g^{(0)} \propto \beta_0$). The hydrodynamical model, based on the irrotational flow motion and using the condition $g^{(0)} \propto \beta_0^2$, is also reformulated to include all the higher-order corrections to the J(J + 1) law. Both the models are

then applied to all the even-even nuclei in the mass regions $152 \leq A \leq 188$ and $A \geq 224$, and the results are compared with experiment. The discussion is restricted to the ground-state rotational bands only. In addition to the rotational-state energies and the ground-state moment of inertia, other nuclear properties, such as the variation of the moment of inertia and the quadrupole moment with the angular momentum, are also investigated. (auth)

54720 UNCERTAINTY IN THE NEUTRON-STRENGTH-FUNCTION EVALUATION FOR A SMALL NUMBER OF MEASURED RESONANCES. Liou, H. I.; Rainwater, J. (Columbia Univ., New York). Phys. Rev., C; 6: No. 2, 435-41(Aug 1972).

When neutron reduced widths, Γ_n^0, are evaluated for N adjacent "single-population" resonances for an isotope, it is customary to express the fractional uncertainty in the s strength function, S_0, as $\pm(2.27/N)^{1/2}$ or $\pm(2/N)^{1/2}$. It is assumed that the Γ_n^0 follow a Porter-Thomas (P.T.) single-channel distribution with a common $\langle\Gamma_n^0\rangle$ for the interval, with no correlation between the different Γ_n^0. If the spacing distribution follows the Wigner formula for nearest neighbor spacings, but with no correlations, the $(2.27/N)^{1/2}$ fractional uncertainty applies for large N. For spacings following a statistical "orthogonal ensemble" (O.E.) behavior, the fractional uncertainty in $\langle D\rangle$ is $\approx N^{-1}$, so the fractional uncertainty in S_0 is $\approx(2/N)^{1/2}$ for large N. Experimentalists need easy to use rules for smaller N. Monte Carlo methods were used with a P. T. form for Γ_n^0, and O.E. for spacings to establish the upper- and lower-bound values for S_0, divided by $\bar{S}_0 \equiv \bar{\Gamma}_n^0/\bar{D}$ (the ratio of the measured averages of Γ_n^0 and D). The method of confidence intervals was used. A "best choice" ratio is suggested for true S_0 to measured $\bar{S}_0$, all for a range of small N. The results should also apply for "single populations" of p levels. The behaviors for Γ_n^0 and D were also studied separately. (auth)

54721 NEUTRON–PROTON INTERACTION IN MIRROR NUCLEI. Jaenecke, Joachim (Max-Planck-Institut fuer Kernphysik, Heidelberg). Phys. Rev., C; 6: No. 2, 467-8(Aug 1972).

Approximate values for the residual neutron-proton interaction in mirror nuclei are derived from binding energy data. The comparison shows no indications for significant symmetry-breaking charge-dependent nuclear effects. (auth)

54722 ELASTIC PION–NUCLEUS SCATTERING FOR STUDIES OF THE NUCLEAR SURFACE. Kisslinger, L. S. (Carnegie-Mellon Univ., Pittsburgh); Burman, R. L.; Koch, J. H.; Sternheim, M. M. Phys. Rev., C; 6: No. 2, 469-75 (Aug 1972).

The use of elastic $\pi^{\pm}$-nucleus scattering to explore the relative neutron-proton distributions in nuclei is studied theoretically. The large difference between π^+-N and π^--N interactions in the nuclear surface leads to substantial effects. Neutron-radius determinations to 0.1 F appears feasible. (auth)

54723 ALPHA-CLUSTER STRUCTURE OF LIGHT SELF-CONJUGATE 4n NUCLEI IN THEIR GROUND STATES. Basu, M. K. (University Coll. of Science, Calcutta). Phys. Rev., C; 6: No. 2, 476-81(Aug 1972).

From phenomenological considerations, a mass formula is derived to calculate the interaction energy among the last two neutrons and last two protons in a nucleus. This interaction energy is the intra-α-cluster energy of the last α cluster in the nucleus. Then from a proper analysis of these intra-α-cluster energies, a separation of the intra- and inter-α-cluster energies out of the total binding energy of the nucleus is made. Clear ideas about the sizes of the α clusters relative to the size of the free α particle and also about the degree of α clustering in each α nucleus are obtained. Positive evidence supporting the additive nature of the α-α-cluster interaction is found. Finally, the intra-α-cluster interaction energies are compared with the nn-, pp-, and np-interaction energies in the same even-even self-conjugate nuclei in order to explore the similarities between the nature of two-body and four-body interactions. (auth)

54724 PION–NUCLEON POTENTIALS FOR USE IN LOW-ENERGY NUCLEAR PHYSICS. Desgrolard, P.; Hammann, T. F. (Institut d'Etudes Nucleaires, Algiers). Phys. Rev., C; 6: No. 2, 482-6(Aug 1972).

One- and two-term nonlocal separable potentials are determined to fit all partial S-, P-, and D-wave experimental phase shifts up to the first energy resonance at about $E_\pi = 180$ MeV (lab). The theoretical and experimental phase shifts, scattering lengths, and volumes are in good agreement. The practical use of this potential in nuclear physics calculations is simplified by the choice of simple form factors and of identical ranges in all S, P, and D relative states. (auth)

54725 ISOMER RATIOS FROM LOW PRIMARY EXCITATION OF RESIDUAL NUCLEI. Watson, J. W. (Knolls Atomic Power Lab., Schenectady, N. Y.); Medicus, H. A.; Turner, R. E. Phys. Rev., C; 6: No. 2, 497-505(Aug 1972).

A calculational procedure based on the Huizenga–Vandenbosch formalism for the determination of isomer ratios has been developed which is applicable also at low primary excitation energies of the residual nuclei, in contrast to earlier methods. This has been accomplished by introducing level densities which are based on the shell-model level calculations of Hillman and Grover rather than a level-density formula. Furthermore, the assumption that all the neutrons are emitted with the average energy 2T (where T is the nuclear temperature) has been replaced by a more realistic neutron spectrum. In order to test this procedure, the isomer ratio of ^{87}Y from the photonuclear reaction ^{89}Y(γ,2n), which has its reaction threshold at 20.8 MeV, was measured for bremsstrahlung of end-point energies 23, 25.6, 28.6, and 50 MeV. The results of the method are in much better agreement with the experiment than the original Huizenga–Vandenbosch approach. The analysis indicates that a relatively large fraction of the product nuclei is formed directly in the ground state and that quadrupole transitions are an important decay mode near the threshold. (auth)

54726 SUPERHEAVY HARTREE–FOCK CALCULATIONS. Saunier, G.; Rouben, B. (Univ. of Montreal). Phys. Rev., C; 6: No. 2, 591-5(Aug 1972).

The superheavy region is explored using a recent two-body interaction which yields, in the Hartree–Fock framework, very good radii and good binding energies for known spherical nuclei, and also a well-ordered occupied ^{208}Pb spectrum near the Fermi surface. A strong shell effect is found for elements $^{114}_{184}$ and $^{120}_{184}$ and a less pronounced one for $^{114}_{182}$, $^{114}_{228}$, $^{120}_{182}$, and $^{120}_{228}$. Their spectra do not lead to allowed β transitions, and for α decay, $^{114}_{184}$ is favored over all others except $^{114}_{228}$. However, the former exhibits a greater binding energy per particle and is closer to the β-stability line predicted by the semiempirical formula. (auth)

54727 NONELASTIC INTERACTIONS OF NUCLEONS AND π MESONS WITH COMPLEX NUCLEI AT ENERGIES BELOW 3 GeV. Bertini, Hugo W. (Oak Ridge National Lab., Tenn.). Phys. Rev., C; 6: No. 2, 631-59(Aug 1972).

Nonelastic interactions corresponding to continuum-state transitions are calculated using the intranuclear-cascade evaporation approach. Spallation yields, energy- and angle-dependent spectra, particle multiplicities, and nonelastic cross sections are calculated for incident nucleons and π mesons with energies below 3 GeV on complex nuclei. Comparisons with experimental data are made and, in general, the agreement is good. Discrepancies in these comparisons are discussed with respect to the deficiencies in the model. (auth)

54728 CORRELATIONS WITHOUT TEARS. Jackson, A. D. (Univ. of Copenhagen); Lande, A. Nucl. Phys.; A191: No. 1, 177-200(1972).

Correlated wave functions and effective operators are obtained using unitary separable approximations to the two-body reaction matrix. These techniques are shown to be both convenient and numerically reliable for purposes of nuclear structure calculations. (auth)

54729 COMPARISON OF SEVERAL CONTINUUM SHELL-MODEL APPROXIMATION SCHEMES. Romo, W. J. (Carleton Univ., Ottawa). Nucl. Phys.; A191: No. 1, 65-87(1972).

A study is made of several schemes designed to give approximate solutions to continuum shell-model problems. The methods studied were all based on a finite-rank approximation to the Lippmann–Schwinger equation. Comparisons are made of both the mathematical basis of the approximation schemes and the accuracies of the methods when applied to a solvable model problem. (auth)

54730 INFLUENCE OF THE CHEMICAL ENVIRONMENT ON α-DECAY. Rubinson, W.; Perlman, M. L. (Brookhaven National Lab., Upton, N.Y.). Phys. Lett.; 40B: No. 3, 352-4(10 Jul 1972).

The effect of a change in the chemical environment of an α-emitter on its decay constant λ, computed on the model of a spatially constant electron density in the region of the Coulomb barrier, is $\delta\lambda/\lambda \approx 10^{-6}$. It is pointed out that on the model used by Alder et al. $\delta\lambda$ is necessarily zero, so their result $\delta\lambda/\lambda \approx 10^{-3}$ is wrong. (auth)

54731 IMPORTANCE OF THE QUADRUPOLE PAIRING FIELD IN THE $J^\pi = 0^+$ VIBRATIONS OF SHAPE DEFORMED NUCLEI. Bes, D. R. (Comision de Energia Atomica, Buenos Aires. Los Alamos Scientific Lab., N. Mex.); Broglia, R. A.; Nilsson, B. Phys. Lett.; 40B: No. 3, 338-44(10 Jul 1972)

The monopole and quadrupole pairing residual interactions acting simultaneously on a system of particles which move in a set of Nilsson single-particle levels and which display a nonuniform distribution of positive and negative quadrupole moments around the Fermi surface give rise to BCS state dependent gaps, which

can produce effects which are similar to those appearing when there is an energy gap in the single-particle spectrum. The competition between monopole and quadrupole pairing correlations allows for the existence of $J^{\pi} = 0^+$ pairing vibrations which carry large (p,t) cross sections and weak (t,p) cross sections or vice versa. This model is used in the analysis of the observed two-nucleon transfer data on the U-isotopes. (auth)

54732 OCTUPOLE DEFORMATIONS IN THE NUCLEI BEYOND ^{208}Pb. Moeller, P.; Nilsson, S. G.; Sheline, R. K. (Lund Inst. of Tech., Sweden). Phys. Lett.; 40B: No. 3, 329-32(10 Jul 1972).

Calculations of the quadrupole (ϵ_2)–octupole ($\epsilon_3(\epsilon_5)$) potential energy surface for nuclei beyond ^{208}Pb indicates the presence of a very low lying secondary minimum in the oblate octupole region of deformation for certain nuclei. The well-known low-lying $K = 0^-$ bands in the Ra–Th region are interpreted as associated with this secondary minimum. (auth)

54733 DESCRIPTION OF THE BAND STRUCTURE AT HIGH ANGULAR MOMENTA IN ROTATING NUCLEI. Krumlinde, J. (Lund Inst. of Tech., Sweden); Szymanski, Z. Phys. Lett.; 40B: No. 3, 314-18(10 Jul 1972).

A simple solvable model of particles coupled to a rotor is introduced. A qualitative description of the band structure in rotating nuclei in the region above the phase transition is given. (auth)

54734 SPURIOUS CENTER-OF-MASS EFFECT IN THE LOCAL DENSITY APPROXIMATION. Zofka, J. (Inst. of Nuclear Physics, Rez, Czech.). Phys. Lett.; 40B: No. 3, 319-22(10 Jul 1972).

An additional spurious center-of-mass effect is caused by using the local density approximation for the density dependent effective interactions. The approximate correction term is suggested and its contribution for the light even-even nuclei is calculated. This contribution is found to be of about +9 MeV and its slight tendency to increase the size and to decrease the deformation of the nucleus is noted. (auth)

54735 EQUATIONS FOR LINKED CLUSTERS AND THE ENERGY VARIATIONAL PRINCIPLE. Kuemmel, H.; Luehrmann, K. H. (Univ., Bochum, Ger.). Nucl. Phys.; A191: No. 3, 525-34(1972).

Explicit equations for linked cluster amplitudes, S_n, for arbitrary n are derived. They are applied to the energy variational principle. The insight gained thereby into the general structure leads to three conclusions: for hard-core potentials an approximate energy variational principle (neglecting in the energy expectation value all cluster functions S_n with $n > N < A$ and nothing else) cannot be formulated; approximations can be made, however, in the equations after performing the variation of the exact expectation value; these approximations lead to renormalized Brueckner–Hartree–Fock theory only if one ignores cancellations due to the existence of four-body cluster equations. (11 figures) (auth)

54736 SEMI-CLASSICAL DESCRIPTION OF ELASTIC AND INELASTIC HEAVY-ION SCATTERING ABOVE THE COULOMB BARRIER. Broglia, R. A.; Landowne, S.; Winther, A. (Univ. of Copenhagen). Phys. Lett.; 40B: No. 3, 293-9(10 Jul 1972).

The coupled-channel semiclassical description of direct reactions between heavy ions is generalized to bombarding energies where nuclear forces begin to play a significant role. The tails of the real and imaginary ion-ion potentials are estimated from the nucleon optical potential. These estimates are used in the analysis of recent elastic and inelastic scattering data. (auth)

54737 SOFT PHOTONS IN POTENTIAL SCATTERING. Nyman, E. M. (Abo Akademi, Finland). Phys. Lett.; 40B: No. 3, 323-5(10 Jul 1972).

An improved soft-photon theorem for non-relativistic bremsstrahlung is given: the elastic-scattering amplitude enters the final formula through functions of the scattering angle at the initial and final energies; the power-series expansion in scattering angle is avoided. (auth)

54738 ATOMIC NUCLEUS. Reid, J. M. Harmondsworth, Eng.: Penguin Books Ltd., (1972). 269p. Pounds 2.35.

The subject is considered in chapters entitled: radioactive decay laws, radioactivity (α decay), radioactivity (β decay), nuclear mass, nuclear shell model, nuclear moments, nuclear moments (experimental measurements), the collective model, excited states of nuclei, and nuclear fission. Appendices give: the ground-state properties of stable nuclei, the passage of charged particles through matter, the interaction of γ rays with matter, general atomic and nuclear constants, a list of the elements in order of charge number and in alphabetical order. (UK)

54739 MASS NUMBER DEPENDENCE OF NEUTRON AND PROTON RESIDUAL INTERACTION. Momoki, Goroh; Sasaki, Kiyoshi (Nihon Univ., Funabashi, Japan). Nihon Daigaku Seisan Kogakubu Hokoku; 4: No. 2, 147-50(Sep 1971).

The properties of the effective neutron and proton interaction are studied. The odd-odd nuclei of the closed shell ± one neutron and one proton are treated. Using the finite range central force with the spin independent and dependent ones, the depth and mixture parameters of the potential are determined. (auth)

54740 BETA-PROTSESSY. FUNKTSII DLYA ANALIZA BETA-SPEKTROV I ELEKTRONNOGO ZAKHVATA. (Beta-Processes. Functions for Analyzing Beta-Spectra and Electron Capture). Dzhelepov, B. S.; Zyryanova, L. N.; Suslov, Yu. P. Leningrad; Izdatel'stvo Nauka Leningradskoe Otdelenie (1972). 374p.

Tables of numerical values of functions useful in the analysis and treatment of experimental data on β decay and capture of orbital electrons are presented. The self-consistent potential of Hartree-Fock-Slater was used in describing the field of atomic electrons in the computation of the functions. The charge distribution in the nucleus was assumed to be homogeneous with respect to the volume of a sphere whose radius was $R = 1.2\ A^{1/3}$. Beta spectra, electron capture from the K-, L-, M-, and $N_{I,II}$• subshells of an atom, and branching coefficients K/β^+ and ϵ/β^+ are tabulated. Tables of accessory data for treatment of beta spectra and the calculation of electron capture are included in an appendix. (K.S.W.)

54741 BOSON EXPANSIONS AND HARTREE–BOGOLYUBOV THEORY. Marshalek, E. R.; Holzwarth, G. (Technische Univ., Munich). Nucl. Phys.; A191: No. 2, 438-48(1972).

If the boson operators in boson expansions of the Hamiltonian are suitably replaced by c-numbers regarded as variational parameters, solutions of the Hartree-Bogoliubov or Hartree-Fock-Bogoliubov equations are obtained. The c-number replacement in the boson equations of motion yields solutions of the corresponding time-dependent self-consistent field equations. (auth)

54742 NUMERICAL INVESTIGATIONS WITHIN THE SEMI-CLASSICAL TRANSFER THEORY. Alder, K.; Morf, R.; Pauli, M.; Trautmann, D. (Inst. of Theoretical Physics, Basel). Nucl. Phys.; A191: No. 2, 399-416(1972).

A short review of the semiclassical transfer theory for neutron- and proton-transfer reactions is presented, which should serve as a guide for planning experiments. The transfer function $B_\lambda(\partial,\rho,\xi,\delta)$ and $H_\lambda(\rho,\xi,\delta)$ describing the kinematics of the transfer reactions are tabulated in the form of contour plots. Furthermore, an estimate of the other quantities which occur in the cross-section formula is given. (auth)

54743 COULOMB BREAK-UP OF THE DEUTERON. Baur, G. (Max-Planck-Institut fuer Kernphysik, Heidelberg); Trautmann, D. Nucl. Phys.; A191: No. 2, 321-31(1972).

A DWBA treatment of the break-up of a deuteron in the Coulomb field of a nucleus is given. A Hulthén wave function is used for the deuteron. There are no free parameters in the theory; therefore, a measurement of this process would give a test of the accuracy of the DWBA. The integral over the continuum wave functions can be reduced to a bremsstrahlung integral given by Sommerfeld and Nordsiek. Numerical calculations for various deuteron energies and targets Z have been performed in order to understand the main features of the process. Coincidence cross sections, cross sections integrated over proton or neutron angles and finally total cross sections are given, along with a discussion of the results. (auth)

54744 RELATIVISTIC NUCLEAR MATTER CALCULATIONS AND THE DEFICIENCY OF ONE-BOSON EXCHANGE POTENTIALS. Lee, Tsung-shung H.; Tabakin, Frank (Univ. of Pittsburgh). Nucl. Phys.; A191: No. 2, 332-52(1972).

Nuclear matter properties are calculated using the Schierholz and Thompson-Gersten-Green relativistic potentials. The Brueckner equations for nuclear matter are modified to incorporate corresponding relativistic kinematics. It is found that both relativistic and non-relativistic one-boson exchange potentials yield overbinding and collapse of nuclear matter. By comparing the relativistic results and earlier non-relativistic results, it is shown that the main deficiency of OBE models is not the use of a non-relativistic limit but is rather the lack of a strong intermediate- and short-range tensor force. The proper treatment of 2π exchange might yield the requisite strong tensor force. (auth)

54745 LIGHT NUCLEI SYSTEMATICS IN THE UNRESTRICTED HARTREE–FOCK APPROXIMATION. Lee, H. C.; Cusson, R. Y. (Chalk River Nuclear Labs., Ont.). Ann. Phys. (N. Y.); 72: No. 2, 353-427(Aug 1972).

Extensive unrestricted Hartree–Fock (HF) calculations are performed for 57 light nuclei in the region $4 \leq A \leq 41$, $N - Z = 0, \pm 1$.

An expansion basis consisting of the first 5 major shells plus the $0h_{\frac{11}{2}}$ subshell of the j−j coupled spherical harmonic oscillator model is used, so that 82 proton and 82 neutron states are considered. The semirealistic N−N interaction No. 2 of Saunier and Pearson is used and seen to be a reasonable energy- and density-independent approximation to the required reaction matrix. All quantum numbers of the Hamiltonian are violated in the single-particle (sp) orbits, except parity and isospin projection τ_z. Time-reversal violation in the sp orbits is shown to be an important effect in odd and odd−odd nuclei and accounts for most of the odd−even pairing energy differences, although no pairing correlations are considered explicitly. No projection from the intrinsic states is performed, but its probable effects are discussed. The Coulomb two-body interaction is included, and its matrix elements are computed exactly by using Talmi integrals. The kinetic energy of the center-of-mass (c.m.) is removed from H before the HF iterations and rms radii are computed with respect to the c.m. so that spurious c.m. effects are minimized. Nilsson-model wave functions are used as initial trial wave functions, and shown to be good approximations for the HF wave functions. Reasonable-to-good agreement with experiment is obtained for the systematics of binding energies, separation energies, rms radii, electric quadrupole moments, and Coulomb energies. Alpha clustering is observed in the density distribution. New quantitative predictions are made for proton−neutron rms radii differences and isospin mixing coefficients, and compared with other calculations. It is concluded that a systematic quantitative account of the ground-state properties of the light nuclei can be given from a knowledge of the N−N interaction and nuclear matter properties alone. (33 figures, 8 tables, 104 references) (auth)

54746 NON-LOCAL POTENTIAL FOR SINGLE-PARTICLE PROPERTIES OF NUCLEI. Janiszewski, J.; McCarthy, I. E. (Flinders Univ. of South Australia, Bedford Park). Nucl. Phys.; A192: No. 1, 85-96(1972).

A real nonlocal potential is developed which describes single-particle properties of nuclei as a function of A and Z. It is useful as a first approximation for nuclear physics applications requiring simple computation of sets of single-particle wave functions. The fits to single-particle energy levels of spherical nuclei and charge distributions are comparable in quality with those obtained by recent Hartree−Fock calculations. Neutron density distributions parallel closely those of the Hartree−Fock calculation. (auth)

54747 EFFECTIVE NEUTRON-PROTON INTERACTION IN DEFORMED DOUBLY ODD NUCLEI. Nakagawa, Kimiko; Obinato, Toshio; Sasaki, Kiyoshi (Nihon Univ., Japan). Nucl. Phys.; A191: No. 3, 535-44(1972).

Properties of the effective neutron−proton interaction in deformed light nuclei, such as $^{18,20}F$, $^{22,24}Na$, $^{26,28}Al$, $^{30,32}P$, and ^{34}Cl, are studied using experimental data on the energy difference between the two rotational band heads and the mutual interaction energy between the neutron and proton in each nucleus by using a symmetric core rotational model. The results show that the systematics of the experimental data can be explained by the simple model. The value of the effective-force range parameter obtained is fairly short compared with the range which is usually employed in the spherical shell-model calculation. In connection with these results, the effects of the force range and force mixture on the nuclear deformation are discussed. (2 figures, 5 tables) (auth)

PHYSICS (PLASMA AND THERMONUCLEAR)

54748 TECHNOLOGY INDEX FOR PLASMAPHYSICS RESEARCH AND FUSION REACTORS. VOLUME 6, No. 7, 1972. Bibliography, Author Index, Subject Index, Appendix. Leopoldshafen, Ger.; Zentralstelle fuer Atomkernenergie-Dokumentation (1972). 45p.

This listing contains 226 references on various aspects of the title subjects. (M.O.W.)

Confinement and Heating

54749 (AEC-tr-7330) GENERAL PRINCIPLE OF CURRENT HEATING PROCESSES OF PLASMA IN PULSED z-DISCHARGES. Dubovoi, L. V. (Scientific Research Inst. of Electro-Physical Apparatus, Leningrad (USSR)). Translation of report NP-18947. 7p. Dep. NTIS.

It is shown that in plasma heating processes in pulsed z-discharges, the gas-kinetic pressure nT of particles is related to the discharge current field B_ϕ by the general law $nT \simeq \beta_\phi(B_\phi^2/8\pi)$ (where β_ϕ = const ~ 1) for most present-day experiments. Conclusions from this relation and generality of its character are discussed. (auth)

54750 (CONF-720705-2) MEASUREMENT OF EFFECTIVE COLLISION FREQUENCY IN RF HEATING THROUGH PARAMETRIC INSTABILITIES. Chu, T. K.; Hendel, H. W. (Princeton Univ., N. J. Plasma Physics Lab.). [nd]. Contracts AT(11-1)-7073; F30602-72-C-0053. 10p. Dep. NTIS.

From first topical conference on rf plasma heating; Lubbock, TX. (6 Jul 1972).

Enhanced absorption of an em wave near ω_{pe} was observed, coincident with the onset of parametric decay instability, in a Q-device plasma. The effective collision frequency $\nu_{eff} \simeq \nu_{ei}(E/E_{cr})^2$. (auth)

54751 (CONF-720705-3) PARAMETRIC INSTABILITY AND ITS INDUCED HEATING. Chu, T. K. (Princeton Univ., N. J. Plasma Physics Lab.). [nd]. Contracts AT(11-1)-3073; F30602-72-C-0053. 15p. Dep. NTIS.

From first topical conference on rf plasma heating; Lubbock TX. (6 Jul 1972).

Laboratory experiments having high-frequency excitation electric fields near ω_{pe} are reviewed. Effects of the inhomogeneity of plasmas are discussed, and the potential use of parametric instability in plasma heating is assessed. (auth)

54752 (CONF-720804-4) WAVE GENERATION AND HEATING NEAR THE ION CYCLOTRON FREQUENCY IN THE ST TOKAMAK. Hooke, W. M.; Hosea, J. C. (Princeton Univ., N. J. Plasma Physics Lab.). [nd]. Contract AT(11-1)-3073. 4p. Dep. NTIS.

From fifth European conference on controlled fusion and plasma physics; Grenoble, France (21 Aug 1972).

A test coil is presently being used to determine the feasibility of employing waves to further heat the ions of the tokamak plasma. Initial results for wave loading of the coil and ion heating are very encouraging. (auth)

54753 (CONF-720804-5) PSEUDOCLASSICAL AND ANOMALOUS CONTAINMENT IN FM-1. Okabayashi, M.; Schmidt, J.; Sinnis, J.; Yoshikawa, S. (Princeton Univ., N. J. Plasma Physics Lab.). [nd]. Contract AT(11-1)-3073. 4p. Dep. NTIS.

From fifth European conference on controlled fusion and plasma physics; Grenoble, France (21 Aug 1972).

Particle confinement times well in excess of one second are observed on FM-1. Below about 1 eV the confinement time scales as $T_e^{3/4}(m \sim {}^3/_4)$, while above 1 eV the confinement time scales as $T_e^n(n \sim -1)$. (auth)

54754 (LA-5019) LOW-DENSITY LIMIT OF THE THETA PINCH. Kaufmann, Michael (Los Alamos Scientific Lab., N. Mex.). Aug 1972. Contract W-7405-eng-36. 9p. Dep. NTIS.

The scaling of the onset of sheath broadening in θ-pinch implosions is derived on the basis of a number of assumptions. The most realistic is that the instability threshold is that of the electron–cyclotron-drift instability and that the electrons are heated by resistive or diffusive field mixing during the implosion. This scaling is used to order various existing high-voltage θ-pinch experiments and to predict the conditions for excessive broadening of the sheath in future θ pinches and other shock-heating experiments. (auth)

54755 EFFECT OF PLASMA FLOW ON TOROIDAL CONFINEMENT. Green, B. J. (Max-Planck-Institut fuer Plasmaphysik, Garching, Ger.). Nucl. Fusion; 12: No. 4, 475-83(Jul 1972).

An attempt is made to review recent developments in the study of laminar plasma flow and its effect on toroidal plasma confinement. The topic is presently the object of active research, so that this summary will serve rather as a progress report of development. Discussion will almost exclusively concern the collision-dominated plasma case, as this has received most attention. The different approaches to the problem are classified and presented in such a way as to indicate the status of results which have been achieved, and to highlight the outstanding problems. (auth)

54756 PLASMA CONTAINMENT IN HYBRID FIELDS OF MIRROR WITH QUADRUPOLE AND QUADRUPOLE-CUSP. Morimoto, Shigeyuki (Nagoya Univ., Japan). J. Phys. Soc. Jap.; 33: No. 3, 761-8(Sep 1972).

Containment of gun-produced plasma in stabilized mirror fields is studied: Quadrupole and quadrupole-cusp fields are produced by two and four inner conductors, respectively. The plasma parameters are $n = 10^9$ to 10^{10} cm^{-3}, $T_e = 1$ to 5 eV, T_i (in the mirror quadrupole) $\gtrsim 10$ eV. Flute instability observed in the mirror field is eliminated by superposing the quadrupole field Superposition of the quadrupole-cusp field does not suppress the instability satisfactorily, but when a wall is provided near the stabilizing winding, as in the usual min-B mirror machine, the plasma is well stabilized. These phenomena are explained by the stability $\int(1/B)dl$ with suitable integral limits. The mirror quadrupole field whose lines of force do not contact with the chamber wall has a good stability integral and is promising as a mirror configuration. (auth)

54757 ATOMIC AND CLUSTER INJECTION INTO D-T MIRROR FUSION POWER SYSTEMS. Hiskes, J. R. (Univ. of California, Livermore). Nucl. Fusion; 12: No. 4, 423-32(Jul 1972).

The problem of the penetration of a neutral atomic beam and a cluster ion beam into a fusion plasma is reviewed. The short penetration length of an atomic beam, coupled with certain geometric dependences of the magnet coil costs, implies an optimum injection energy for a D–T mirror fusion power system in the range 200 to 300 keV. The penetration length for a cluster beam is inferred from available data. For certain charge and mass distributions of the cluster fragments, a substantial improvement of beam penetration is possible, allowing for injection as low as 100 keV per deuteron. Additional fragment-charge and mass-distribution data will be necessary, however, to clarify the role of cluster injection. (auth)

54758 MICROWAVE PLASMA HEATING IN TUMAN-2. Golant, V. E.; Kaganskii, M. G.; Pakhomov, L. P.; Podushnikova, K. A.; Shakhovets, K. G. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Tech. Phys. (Engl. Transl.); 17: No. 3, 488-94(Sep 1972).

Translated from Zh. Tekh. Fiz.; 42: No. 3, 620-8(Mar 1972).

Experiments on microwave plasma heating were carried out at frequencies in the upper-hybrid range. At plasma densities (1 to 3) $\times 10^{12}$ cm^{-3}, f = 9 GHz, and P = 80 kW, the efficiency of microwave energy injection, as given by the change in plasma parameters, is several tens of percent. At plasma densities (1 to 2) $\times 10^{13}$ cm^{-3} and f ~ 34 GHz, the efficiency falls to 5 to 10%. Since the wavelength is considerably smaller than the chamber dimensions, the change of efficiency with frequency is possibly due to the effect of an opaque region. (auth)

54759 ASYMPTOTIC PARTICLE DISTRIBUTION FUNCTION IN CYCLOTRON HEATING. Polovin, R. V. (Physical-Technical Inst., Kharkov). Sov. Phys.-Tech. Phys. (Engl. Transl.); 17: No. 3, 416-17(Sep 1972).

Translated from Zh. Tekh. Fiz.; 42: No. 3, 526-7(Mar 1972).

Cyclotron heating in a magnetic trap is investigated. The magnetic field is assumed to be constant and homogeneous, while the electric field is assumed to be spatially homogeneous and rotating with the cyclotron frequency. It is shown that the asymptotic form of the energy distribution function of the particles is an exponential that contains a negative radical. (auth)

54760 MAGNETIC-FIELD-ENHANCED HEATING OF PLASMAS WITH CO_2 LASERS. Cohn, Daniel R.; Lax, Benjamin (Massachusetts Inst. of Tech., Cambridge). Appl. Phys. Lett.; 21: No. 5, 217-20(1 Sep 1972).

The effect of high magnetic fields upon the heating rate of CO_2-laser-produced plasmas was calculated. It is found that the inhibition of thermal losses in the presence of high magnetic fields should substantially enhance the effectiveness of the CO_2 laser as

a means of creating hot plasmas. Electron and ion temperatures are computed for plasmas produced with 10^{10}-W CO_2 lasers. (auth)

54761 HIGHER HARMONICS AND TRANSPORT COEFFICIENTS OF PLASMAS IN CIRCULARY POLARIZED MAGNETIC FIELDS AND ADDITIONAL ELECTROMAGNETIC FIELDS. Kirsten, T.; Vojta, G. (Karl-Marx-Univ., Leipzig). Beitr. Plasmaphys.; 12: No. 2, 123-47(1972).

With the methods of kinetic theory on the basis of the Boltzmann and Fokker–Planck kinetic equations, the behavior of a Lorentz plasma in a circularly polarized (rotating) magnetic field (rotation frequency ω), an alternating electric field (frequency ω'), and additional constant electromagnetic fields is investigated. By means of a generalized Fourier expansion it is shown that the above fields create in the plasma currents of the frequencies 0, ω', $\omega - \omega'$, ω, $\omega + \omega'$, $2\omega - \omega'$, 2ω, and $2\omega + \omega'$. Transport coefficients are calculated explicitly and the validity of Onsager reciprocity relations and that of Kronig–Kramers relations is discussed. The special case of the electric field induced by the rotating magnetic field is treated separately. Finally, problems of plasma containment are discussed. (auth)

54762 INFLUENCE OF DIFFERENT TYPES OF OSCILLATIONS ON ION HEATING IN PLASMA–BEAM DISCHARGES. Kovpik, O. F.; Kornilov, E. A.; Krivoruchko, S. M.; Moiseev, S. S.; Fainberg, Ya. B. (Physical-Technical Inst., Kiev). JETP Lett. (USSR) (Engl. Transl.); 15: No. 9, 355-7(5 May 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 15: No. 9, 501-4(5 May 1972).

Experimental results are presented that confirm the predominant energy absorption by plasma ions in the region of the lower hybrid resonance $\omega^2 \simeq \omega_i\omega_e/[1 + \omega_e^2(\omega_e^2)]$ in comparison with heating by oscillations with $\omega \leq \omega_i$. The maximum contribution to the energy absorption by the ions is made by oscillations near the ion-cyclotron frequency ~0.072 MHz and the lower hybrid resonance ~20 MHz. Results show that it is most effective to heat ions by oscillations that cause little transverse diffusion and thermal conductivity. (D.L.C.)

54763 BEHAVIOR OF LARGE-CURRENT ELECTRON BEAM IN A DENSE GAS. Rudakov, L. I.; Smirnov, V. P.; Spektor, A. M. JETP Lett. (USSR) (Engl. Transl.); 15: No. 9, 382-5(5 May 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 15: No. 9, 540-4(5 May 1972).

An electron beam traverses in air a distance which is larger than the mean free path of an electron, before it spreads apart. This effect was investigated in air and He at pressures from 10^{-2} torr to 1.6 atm. 660-keV electrons were used, and the glow curves agree with calorimetric measurements. In air at 1 atm, the beam breaks up at ~12 cm. The penetration length L in air decreases with pressure from 20 cm at 0.4 atm to 10 cm at 1.6 atm. L could not be measured in He as it exceeded the drift chamber. This effect is connected with the appearance of a beam instability in a strongly dissipative medium. The dispersive equation has an instable solution that leads to bunching of the beam and its consequent deceleration. L should lie between $\gamma[(n/n')(\Delta\nu/\nu)]$ and $\gamma[(n/n')(\nu/\nu_e)]$. Estimates of L and its pressure dependence agree with experiment. The use of this effect for collective heating of a superdense plasma is suggested. (D.L.C.)

54764 ONE POSSIBLE USE OF THE IR LASERS FOR HIGH-TEMPERATURE HEATING OF A SUPERDENSE PLASMA. Bunkin, F. V.; Pashenin, P. P.; Prokhorov, A. M. (Lebedev Inst. of Physics, Moscow). JETP Lett. (USSR) (Engl. Transl.); 15: No. 9, 394-7(5 May 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 15: No. 9, 556-9(5 May 1972).

One possible way of solving the problem of feeding the radiation energy into the superdense plasma produced in laser experiments, is discussed. When a strong magnetic field H_0 is applied to the plasma, wave propagation in a quasi-longitudinal direction is possible if $(\omega_H/\omega)\cos\phi > 1$. For effective excitation of the wave, it is necessary to have small angles ϕ_0 and large gradients of the electron density at the point $\omega_p > \omega$. These conditions are satisfied if the width $\Delta Z = (N_e/N_e')_{\omega_p=\omega} \ll 3 \times 10^{-5}\,\phi_0^{-2}$ cm. For a pulse duration of 10^{-9} sec, $\phi_0 < 2 \times 10^{-2}$ rad. For $H_0 \simeq 10^7$ G, the target cross-section area can be $\sim 10^{-4}$ cm^2. The minimum laser energy is estimated to be 3×10^3 J. (D.L.C.)

54765 THEORY OF STOCHASTIC HEATING OF PARTICLES IN A TURBULENT PLASMA. Kingsep, A. S. (Inst. of Atomic Energy, Moscow). Zh. Eksp. Teor. Fiz.; 62: No. 6, 2179-82 (Jun 1972). (In Russian).

It is pointed out that, in order to solve the problem of turbulent heating of a plasma, the evolution of the particle distribution function in the matrix elements of the wave nonlinear interaction should be taken into account. It is demonstrated that an ion distribution that decreases with increasing velocity v according to a power law becomes established as heating occurs. It is found that stochastic heating of ions cannot be described by a self-similar solution. (auth)

54766 INVESTIGATION OF HEATING OF A PLASMA ION COMPONENT BY A COLLISIONLESS SHOCK WAVE. Alinovskii, N. I.; Altyntsev, A. T.; Koshilev, N. A. (Inst. of Nuclear Physics, Novosibirsk, USSR). Zh. Eksp. Teor. Fiz.; 62: No. 6, 2121-8 (Jun 1972). (In Russian).

The energy spectra of ions in a plasma heated by a collisionless shock wave are obtained by the technique of passive corpuscular diagnostics. Under conditions when an aperiodic shock front with resistive dissipation is formed in the plasma, ion heating is manifest in the appearance of a small group of ions (~10%) with a mean energy of the order of the electron temperature. The remaining ions are cold. The results are in agreement with a theoretical model which explains the origin of this particle group as being due to Landau linear damping of ion acoustic oscillations excited in a shock wave by resonance ions located at the tail of the distribution function. The main energy content of the plasma is determined by the electron component. Under conditions of overturning of the shock wave front predominant heating of the ion component of the plasma is observed, the ion distribution function being close to the isotropic Maxwellian distribution. (auth)

54767 COLLISIONLESS HEATING OF PLASMA IONS BY AN ION BEAM. Kirichenko, G. S.; Khmaruk, V. G. (Inst. of Nuclear Research, Kiev). Zh. Eksp. Teor. Fiz.; 63: No. 1, 107-11(Jul 1972). (In Russian).

The possibility of employing an ion beam for collisionless heating of plasma ions is investigated. It is shown that the ion temperature can be raised to the electron temperature by excitation of intense low-frequency oscillations by an ion beam in a plasma–beam discharge. (tr-auth)

Diagnostics

Refer also to abstracts 53684 and 54056.

54768 (AEC-tr-7329) MEASUREMENT OF PLASMA PARAMETERS IN STRONG HF DISCHARGE. Dubovoi, L. V.; Ivanov, B. A.; Chernobrovin, V. I. (Scientific Research Inst. of Electro-Physical Apparatus, Leningrad (USSR)). Translation of report NP-18946. 8p. Dep. NTIS.

An attempt is made to use a corpuscular diagnostic method for defining the local characteristics of skinned hf discharge. Plasma density and thermal skin-layer thickness obtained coincide with calculated estimates and measurement data by independent methods. The results of measurements of the ion distribution function in turbulent discharges are presented. (auth)

54769 MEASUREMENT OF THE ELECTRON DENSITY DISTRIBUTION IN PLASMAS FROM THE BENDING OF A GAS LASER BEAM. Potter, I. C.; Falconer, I. S.; Smith, W. I. B. (Univ. of Sydney). J. Phys., E (London); 5: No. 9, 910-14 (Sep 1972).

The electron density distribution in an axisymmetric plasma may be determined by measuring the deviation of a gas-laser beam on passing through the plasma. If the beam is inclined at a small angle to the axis of the plasma the bending is closely proportional to the difference between the axially averaged electron density at the radius at which the beam enters the plasma, and at the radius at which it leaves the plasma. Experimental results demonstrating the validity of this method, and the advantage and limitations of beam bending as a diagnostic tool, are discussed. (auth)

54770 CIRCUIT FOR DIRECT REGISTRATION OF ELECTRON DENSITIES MEASURED INTERFEROMETRICALLY. Funk, L. W.; Camm, D. M.; Curzon, F. L. (British Columbia Univ., Vancouver). J. Phys., E (London); 5: No. 9, 941-3(Sep 1972).

Electron densities are commonly measured by determining the plasma refractive index with an interferometer. The circuit described permits the electron density to be recorded directly as a function of time. For the 6328-Å line of a He–Ne laser, the device has a sensitivity of 3.56×10^{18} electrons cm^{-2} V^{-1} and a resolving time of the order of 40 ns. (auth)

54771 ANALYTICAL AND EXPERIMENTAL INVESTIGATIONS OF THE TRANSIENT PROPERTIES OF DENSE ALUMINIUM PLASMAS. Willis, Harold Wayne. Stillwater, Okla.; Okla-

homa State Univ. (1971). 248p. University Microfilms Order No. 72-22,014.

Thesis.

The scope of this work includes the theoretical study of the laser impact and expanding sphere plasma computer models and the experimental study of the laser impact and vacuum spark plasmas with the quadrupole mass filter and the electrostatic lens system. A number of experimental curves were obtained which contribute information on the ionic species of aluminum atoms, the presence of metastable atoms and the ultraviolet light that is emitted by the vacuum breakdown of a spark gap. These measurements, which were taken with the quadrupole mass filter and an electrostatic lens, appear to establish that migration of the spark at the anode occurs during the breakdown. Several curves of the velocity distribution are presented for aluminum ions: Al^{+1} through Al^{+5}. The general conclusion from this study is that the analytical studies, based on the assumption of local thermodynamic equilibrium, have a good basis for application, for the escaping ions approximate a Maxwell–Boltzmann distribution, but the analytical equations are not exact. The computer model for the laser impact plasma was completely formulated in collaboration with L. J. Peery, and a one and one-half hour production run was obtained. Data from the run are included. A new, improved program for the analytical model of an expanding plasma sphere was formulated. The computer program and initial results are presented. (TSS) (Diss. Abstr. Int., B)

54772 DETERMINATION OF THE MAGNETIC FIELDS IN A PLASMA ON BASIS OF THE HYDROGEN SPECTRAL LINE CONTOURS. Demura, A. V.; Lisitsa, V. S. (Inst. of Atomic Energy, Moscow). Zh. Eksp. Teor. Fiz.; 62: No. 6, 2161-9(Jun 1972). (In Russian).

An approximate analytic solution is obtained for the problem pertaining to deformation of the Holtsmark contour of the hydrogen spectral line by an external magnetic field B. The solution yields the difference contour derived by subtraction of two contours corresponding to polarization along and across the magnetic field. A method for determining the magnitude and direction of B by means of the difference contour expressed in terms of three universal functions related to the Holtsmark function is considered. Numerical results for components of the L_α and L_β lines are presented. The possibility of determining the exact analytic solution for a complete line contour is discussed. (auth)

54773 USE OF HIGH-SPEED SPECTROGRAPHY FOR DIAGNOSTICS OF AN EROSIVE PULSED PLASMA ACCELERATOR. El'yashevich, M. A.; Avramenko, V. B.; Bakanovich, G. I.; Min'ko L. Ya. Zh. Prikl. Spektrosk.; 16: No. 3, 422-5(Mar 1972). (In Russian).

Individual frame photographs of spectra were tested for quantitative spectroscopic studies of an erosive pulsed, plasma accelerator. By broadening the spectral lines and the brightness of the continuous spectrum, a spatial distribution of the concentration of charged particles was obtained in discrete moments of time with respect to the photographic frames of the spectra of the transverse cross section of the plasma jet. Particle concentration measurements on a time base showed that the integrated value of the concentration with respect to time was too low in comparison with the maximum values. (tr-auth)

Kinetics (General)

54774 (AEC-tr-7323) PLASMA BREMSSTRAHLUNG FROM RELATIVISTIC PARTICLES IN A TURBULENT PLASMA. Tsytovich, V. N. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). Translation of report NP-18759. 19p. Dep. NTIS.

The existence of two mechanisms of radiation of relativistic particles in turbulent plasma is demonstrated: (1) Previously examined process of induced and spontaneous radiation during Compton scatter on nonresonance turbulent vibrations of plasma; (2) new effect—bremsstrahlung during scatter on resonant turbulent vibrations. The spectral composition and angular distribution of the radiation, particle energy losses due to plasma-bremsstrahlung are analyzed. The effect of low-multiple scatter (Landau–Pomeranchuk effect) on radiation processes is investigated. The strength of plasma-bremsstrahlung depends little on particle mass and is great in particular for ions. The effect of turbulent expansion of Cherenkov resonance, examined earlier, is interpreted as being the result of multiple scatter of particles on resonance plasma pulsations. (auth)

54775 (AEC-tr-7326) CIRCUITS FOR STUDYING THE INTERACTION OF HIGH-FREQUENCY FIELDS WITH A PLASMA IN LINEAR DEVICES. Savchenko, I. S.; Yampol'skii, I. R. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Sukhumi. Fiziko-Tekhnicheskii Institut). Translation of report NP-18895. 18p. Dep. NTIS.

Diagram solutions of circuits forming high-frequency electromagnetic fields in experimental plasma devices with cylindrical discharge chambers are described. Circuits producing transverse rotating fields with various numbers of poles (p = 0,1,2) are considered. The circuits consist of eight rods located uniformly around the generatrix of a cylinder and connected in various ways with circuit condensers in an artificial retention line closed into a ring or in the form of individual magnetically connected circuits. The proposed circuits can be excited from a four-phase voltage source that ensures high symmetry of the field. The circuits can be excited simultaneously at two frequencies. Each frequency corresponds to different values of p. The properties are discussed and computational formulas for determining the basic parameters and some information on the practical achievement of the circuits are given. (auth)

54776 (AEC-tr-7332) RATIO OF LONGITUDINAL AND TRANSVERSE DIFFUSION COEFFICIENTS IN ARGON SHF DISCHARGE PLASMA. Budnikov, V. N.; Novik, K. M.; Obukhov, A. A. (Akademiya Nauk SSSR, Leningrad. Fiziko-Tekhnicheskii Institut). Translation of report NP-18916. 5p. Dep. NTIS.

The results are presented of determination of the ratio of longitudinal and transverse diffusion coefficients in argon plasma, obtained on the basis of analysis of the longitudinal concentration distribution of charged particles outside the active zone of shf discharge. The experimental conditions were: longitudinal magnetic field about 3,000 Oe, discharge cylinder length 70 cm, diameter 2.5 cm, charged-particle concentration 10^{12} to 10^{10} cm^{-3}, $T_0 \sim 2$ to 10 eV. It was found in the pressure range 3×10^{-2} to 3×10^{-3} mm Hg that the ratio $D_{||}/D_{\perp}$ is constant, equal to 25. (auth)

54777 (BMBW-FBK-72-8) EXPERIMENTAL INVESTIGATION OF THE CONTINUOUS EMISSION OF SHOCK HEATED KRYPTON AND XENON. Weber, W. (Technische Universitaet, Hanover (West Germany). Institut fuer Plasmaphysik). Jul 1972. 110p. (In German). Dep. NTIS (U. S. Sales Only).

The emission coefficients for continuum radiation of shock-heated krypton and xenon plasmas were measured photographically in the wavelength region from 4000 to 6000 Å and the ξ factors for Kr I and Xe I were determined. The plasma temperature and electron density needed for the calculation of the ξ factors were calculated from the velocity of the shock wave with the Rankine–Hugoniot equations. The results are compared with measurements and theoretical calculations of other authors. (auth)

54778 (CEA-CONF-2047) IONIZATION PROCESSES IN HOT PLASMAS. Bliman, S. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). 15 Mar 1972. 6p. (In French). (CONF-720120-2). Dep. NTIS (U. S. Sales Only).

From Conference on the sources of multicharged ions; Paris, France (28 Jan 1972).

The various types of collisions leading to multiply charged ions are considered. Step-by-step ionization and shake-off ionization in hot plasmas are envisaged. (France)

54779 (NP-19393) PHYSICS DISCIPLINE. Annual Progress Report, 1971. (Flinders Univ. of South Australia, Bedford Park. School of Physical Sciences). Dec 1971. 66p. Dep. NTIS (U. S. Sales Only).

Research being conducted in the fields of discharge and plasma physics and atomic scattering, and theoretical studies in nuclear and many-body physics are outlined. Plasma studies include normal ionizing, gas dynamic and collisional studies of shock waves; wave propagation; and interaction between high frequency fields and plasmas (including anomalous skin effects). Other topics are gaseous breakdown and electron transport phenomena and atomic collision processes (electron–atom) including excitation of Ne and Ar; magnetohydrodynamics; statistical mechanics and many body theory; and computational physics. Theoretical nuclear physics is centered on the three-body problem. Studies include pion–deuteron production, d(p,2p)n–impulse approximation and distorted wave theory with s-wave t-matrix; Coulomb contribution to the t-matrix; extensions of the Faddeev equation; off-shell effects in the bound state; and a unitary pole expansion for the coupled-channel case. (Australia)

54780 (NP-19414) WILLS PLASMA PHYSICS DEPARTMENT TWENTY-THIRD SIX-MONTHLY PROGRESS REPORT, 1st JANUARY-30th JUNE 1972. (Sydney Univ. (Australia). School of Physics). 1972. 8p. (PR-23). Dep. NTIS (U. S. Sales Only).

Progress in the following topics is summarized: plasma sources; hydromagnetic ionizing fronts; plasma decay; rotating plasmas; cyclotron harmonic waves; hydromagnetic waves; laser diagnostics; and far-infrared. (Australia)

54781 ENERGY-TRANSFER EFFICIENCY OF A MAGNETIC-IMPLOSION SYSTEM. Timonin, A. M. (Scientific-Research Inst. of Electrophysical Apparatus, Leningrad). Sov. Phys.-Tech. Phys. (Engl. Transl.); 17: No. 2, 344-5(Aug 1972).

Translated from Zh. Tekh. Fiz.; 42: No. 2, 433-5(Feb 1972).

The efficiency with which energy is converted into the energy of a magnetic field in a magnetic-implosion system is found as a function of the flux compression and the field amplification. If the flux compression is limited, an extremely strong initial compression field is required for high efficiency. (auth)

54782 INTERACTION BETWEEN A PLASMA AND ELECTRON BEAM MODULATED BY LOW-FREQUENCY OSCILLATIONS. Berezina, G. P.; Fainberg, Ya. B.; Berezin, A. K.; Zeidlits, V. P. (Physical-Technical Inst., Kharkov). Zh. Eksp. Teor. Fiz.; 62: No. 6, 2115-20(Jun 1972). (In Russian).

The possibility of regulating the low-frequency oscillation spectra in a plasma–beam discharge by means of external low frequency modulation of the electron beam is studied. The high efficiency of this modulation technique is demonstrated. Low-frequency oscillations can be introduced into the beam–plasma system by deep modulation of the beam. When the modulation frequency is the same as that of the proper low-frequency plasma oscillations, the latter are excited in a resonant manner and suppression occurs of those oscillations (including drift oscillations) whose frequencies differ from the modulation frequency; moreover, the degree of turbulency of the oscillations in the low-frequency region decreases. (auth)

54783 NONSTATIONARY SOLENOIDAL REGULAR FLUXES OF LIKE-CHARGE PARTICLES. Ogorodnikov, S. N. Izv. Vyssh. Ucheb. Zaved., Radiofiz.; 15: No. 5, 792-4(1972). (In Russian).

Previous authors have investigated a two-dimensional nonstationary, nonrelativistic solenoidal regular flux of similar charged particles in the absence of a magnetic field, or in a magnetic field perpendicular to the plane of motion. This paper is concerned with an analogous flux in a completely random magnetic field. (K.S.W.)

Kinetics (Experimental)

54784 (IPP-1/125) DEVELOPMENT AND PROPERTIES OF THE HALO IN PINCH PLASMAS. Freund, Juergen (Max-Planck-Institut fuer Plasmaphysik, Garching (West Germany)). Feb 1972. 94p. (In German). Dep. NTIS (U. S. Sales Only).

In pinch discharges a second plasma region outside the central plasma column has been observed, which is called halo in some of the literature. This surrounding plasma was investigated in the experiments with the 5.4-m-long compression coil in the ISAR I linear theta pinch because there it appears highly pronounced. The development of the discharge was observed side-on (stereoscopic) with image converters and a streak camera. It appears possible to resolve the space–time behavior of the plasma, especially in the dynamic phase of the discharge, by using high-speed color reversal film (streak camera). Furthermore, the smear pictures show that after 6 to 8 μsec the halo region is frozen into the external magnetic field, i.e., from this time the halo is characterized by a high electric conductivity. The boundary layer of the halo follows a magnetic flux tube. The parameters of the halo, such as electron density, atomic temperature, and ion temperature were determined spectroscopically as a function of time and location from the broadening of the deuterium Balmer lines. (auth)

54785 PASSAGE OF HIGH-POWER LASER RADIATION THROUGN AN OPTICALLY DENSE PLASMA. Burakov, V. S.; Haumenkov, P. A.; Ivanov, V. P.; Kolosovskii, G. A. Zh. Prikl. Spektrosk.; 16: No. 2, 239-42(Feb 1972). (In Russian).

The transmission of ruby laser radiation (density 10^6 to 5×10^6 watt/cm^2) with a duration of 3×10^{-9} sec through a quasi-stationary plasma was studied. The plasma was contained in an electrical discharge in a capillary and had a temperature of about 4 eV. Nonlinear phenomena were observed during the passage of the laser radiation through the plasma, with an increase in the absorptive properties of the latter. (tr-auth)

54786 DIRECT MEASUREMENT OF DIFFUSION COOLING IN AN AFTERGLOW PLASMA. Boulmer, J.; Sol, C.; Gauthier, J. C. (Univ. Paris, Orsay, France). Phys. Lett.; 41A: No. 1, 83-4(28 Aug 1972).

Measurements of the electron temperature lowering by diffusion cooling in xenon afterglow plasmas are reported. They are in good agreement with available semi-quantitative theories. (auth)

54787 STIMULATED EMISSION EVOKED BY PUMPING WITH A PULSED ELECTRON BEAM PRODUCED IN A LINEAR DISCHARGE. Averin, V. G.; Karchevskii, A. I.; Yurkin, G. V. (Inst. of Atomic Energy, Moscow). Zh. Eksp. Teor. Fiz.; 63: No. 1, 85-91(Jul 1972). (In Russian).

It is demonstrated experimentally that on collective interaction between a powerful pulsed electron beam (~100 MW) produced in a large-current linear discharge and a preformed argon plasma with $n_0 = (3 - 5) \cdot 10^{13}$ cm^{-3}, argon–ion stimulated emission arises. The generation occurs in the visible (Ar II, λ4764 Å, λ4880 Å) and ultraviolet (Ar III, λ3511 Å, λ3638 Å) spectral ranges. The generation power for the Ar II transition is ~1 kW. (tr-auth)

Kinetics (Theoretical)

54788 (EUR-CEA-FC-642) COLLISIONAL-RADIATIVE VOLUME RECOMBINATION AND IONIZATION COEFFICIENTS FOR He^+–He^{2+}–e PLASMAS. Drawin, H. W.; Emard, F. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Mar 1972. 29p. Dep. NTIS (U. S. Sales Only).

Coefficients are calculated for the collisional–radiative recombination of doubly ionized He atoms with electrons, and the collisional–radiative ionization of singly ionized He atoms into doubly ionized He atoms by electronic collisions and radiative absorption. Up to one hundred coupled equations are solved, which correspond to a level scheme in which levels having principal quantum numbers less or equal to 100 are considered. The numerical results are presented in the form of curves corresponding to a large number of parameters representing very different experimental situations. The values obtained are compared with experimental values determined by Mosburg and Gipplus et al. All the numerical values obtained for the collisional–radiative coefficients are presented in tabular form. (France)

54789 (ITF-71-96-P) INTRODUCTION TO PHYSICAL KINETICS. Akhiezer, A. I.; Peletminskii, S. V. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1971. 34p. (In Russian). Dep. NTIS (U. S. Sales Only).

Methods for obtaining the kinetic equations for classical systems are reviewed. These methods are based on the principle of spatial weakening of correlations and the idea first advanced by N. N. Bogolyubov about a multistage character of evolution of many-particle dyanmic systems. A chain of equations is established for many-particle distribution functions, on the basis of which the integral equations for these functions are derived. The solution of these equations by perturbation methods in the limiting cases of weak interaction, low density, and small plasma parameter makes it possible to obtain kinetic equations for one-particle distribution functions in various physically interesting cases. (auth)

54790 (JPRS-56713) SECOND HARMONIC GENERATION IN NONUNIFORM LASER-PRODUCED PLASMA. Vinogradov, A. V.; Pustovalov, V. V. (Akademiya Nauk SSSR, Moscow. Fizicheskii Institut). Translation of Russian Preprint No. 63. 17p. NTIS.

Coherent second harmonic emission with electromagnetic waves striking a layer of nonuniform plasma whose density exceeds the critical is examined. The temperature of the plasma is assumed to be high enough so that Coulomb collisions are negligible and the structure of the electromagnetic field near the critical point on the basic frequency is governed by the thermal motion of electrons. The above-stated conditions are satisfied in laser plasma with electron temperature $\varkappa T_e \gtrsim 1$ keV and characteristic nonuniformity of 10^{-2} to 10^{-3} cm. In this case the conversion ratio of the laser emission to the second harmonic at optimal angles of incidence may reach 1% at a power of ~10^{13} watt/cm^2. (auth)

54791 RESONANT DIFFUSION IN THE PRESENCE OF STRONG PLASMA TURBULENCE. Birmingham, T. J. (Goddard Space Flight Center, Greenbelt, Md.). Phys. Fluids; 15: No. 10, 1778-85(Oct 1972).

The diffusion equation which describes the evolution of the average one-particle distribution function for an ensemble of strongly turbulent plasmas is derived. The diffusion tensor is a time integral of the autocorrelation tensor of the fluctuations as observed by particles moving along statistically distributed orbits. These orbits contain the effects of fluctuations and thus differ from those encountered in weak turbulence theory. Two statistical orbit effects quadratic in the strength of the fluctuations affect the magnitude of the diffusion: (a) modification of the ensemble average orbits by the fluctuations, and (b) statistical dispersion in particle orbits about the average. The plasma trajectory equations are used to relate each to the diffusion tensor itself when the turbulence is electrostatic. The diffusion tensor is explicitly evaluated for a strongly turbulent unmagnetized plasma. (auth)

54792 RESONANT SCATTERING OF TRAPPED PARTICLES BY TOROIDAL PLASMA MODES. Coppi, B. (Massachusetts

Inst. of Tech., Cambridge); Minardi, E.; Schram, D. C. Lett. Nuovo Cim.; 4: No. 15, 789-93(12 Aug 1972).

Collective modes capable of causing resonant scattering of trapped ions are found to be excited, under realistic conditions on the ion temperature and density gradients, in two-dimensional plasma confinement configurations. In addition, a significant asymptotic limit exists in which the influence of the excited modes on the trapped-particle orbits can be evaluated analytically. The toroidal magnetic field is represented by $B_\zeta = B_0[1 + (r/R_0)\cos\theta]^{-1}$, where r labels the magnetic surface and θ and ζ the poloidal and toroidal angles, respectively. (M.O.W.)

54793 INTERACTION OF A MULTILOOP ELECTRON STREAM WITH A PLASMA. Kotsarenko, N. Ya.; Senkevich, E. L.; Fedorchenko, A. M. (Kiev State Univ.). Sov. Phys.-Tech. Phys. (Engl. Transl.) 17: No. 3, 402-4(Sep 1972).

Translated from Zh. Tekh. Fiz.; 42: No. 3, 508-10(Mar 1972).

The dispersion equation for a multiloop electron stream interacting with slow waves in a cold magnetized plasma is derived and analyzed. It is shown that instabilities occur in this system as a result of both the anomalous and normal Doppler effects. The instabilities are strongest at the lower harmonics of the cyclotron frequency and for wavelengths of the order of the electron Larmor radius. (auth)

54794 INJECTION OF A DENSE ELECTRON BEAM INTO A PLASMA. Rosinskii, S. E.; Rukhlin, V. G. (Inst. of Space Research, Moscow). Sov. Phys.-Tech. Phys. (Engl. Transl.); 17: No. 3, 405-12(Sep 1972).

Translated from Zh. Tekh. Fiz.; 42: No. 3, 511-21(Mar 1972).

The steady-state motion of an electron beam along a magnetic field after injection is discussed. It is shown that a dense beam propagating in a rarefied plasma assumes the shape of a highly corrugated cylinder; the depth of the corrugations is considerably greater than the initial radius of the beam, and the spacing between corrugations is of the order of the distance traversed by the electrons in a cyclotron period. The basic macroscopic parameters characterizing the beam motion are determined. The effect of the polarization properties of the background plasma on a dense beam is investigated. (auth)

54795 INTERACTION OF FINITE PERTURBATIONS IN A BEAM–PLASMA SYSTEM. Matsiborko, N. G.; Onishchenko, I. N.; Fainberg, Ya. B.; Shapiro, V. D.; Shevchenko, V. I. (Physical-Technical Inst., Kharkov). Sov. Phys.-Tech. Phys. (Engl. Transl.); 17: No. 3, 413-15(Sep 1972).

Translated from Zh. Tekh. Fiz.; 42: No. 3, 522-5(Mar 1972).

Equations describing the nonlinear interaction of waves excited in a system consisting of a plasma and a "cold" electron beam are derived and solved numerically. (auth)

54796 ABOUT THE ELECTRONIC SHIFTS OF THE STARK BROADENED LYMAN-α LINES. Caby–Eyraud, M.; Nguyen-Hoe (Univ., Paris). J. Phys., B (London); 5: No. 8, L153-6(Aug 1972).

Shift and asymmetry of broadened hydrogen lines in plasmas are investigated. All contributing multipoles and interactions between states with different principal quantum numbers (quenching effect) are included in the atom-perturber potential V(t). Numerical results are given for Ly_α line in the impact limit. Especially, for $T = 5 \times 10^4$K, the shift arising from quenching effect is eight times greater than that arising from quadrupole and monopole. (auth)

54797 KINETIC EQUATIONS. Liboff, Richard L.; Rostoker, Norman (eds.). New York; Gordon and Breach, Science Publishers, Inc. (1971). 356p. $19.50.

A collection of 24 papers and 1 abstract are given that deal with the following aspects of kinetic theory: (1) axiomatics, (2) quantum and relativistic, (3) properties and solutions, and (4) waves and fluctuations. Several of the papers deal directly with kinetic equations for plasmas. (M.O.W.)

54798 INDUCED COMPTON EFFECT IN A PLASMA. Babuel-Peyrissac, J. P. (CEA, Villeneuve-Saint-Georges, France). Phys. Lett.; 41A: No. 2, 143-4(11 Sep 1972).

It is shown that the induced Compton effect explains the generation of a Stokes line in a recent experiment of plasma irradiation by the light of a laser. (auth)

54799 KINETIC PROCESSES IN A LASER PLASMA. Afanas'ev, Yu. V.; Belenov, E. M.; Krokhin, O. N.; Poluektov, I. A. (Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz.; 63: No. 1, 121-30(Jul 1972). (In Russian).

Kinetic processes in a high-temperature ($T_e \geq 1$ keV) laser plasma are investigated theoretically. The condition of a strong field for which the plasma state is not equilibrium is derived. The kinetic equation for the plasma electron distribution function is investigated under strong field conditions. The electron distribution function in a multicharge plasma ($z \gg 1$) is calculated analytically, and expressions are obtained for its parameters (temperature, ionization multiplicity, proper emission spectra) as functions of intensity and duration of the laser pulse. (tr-auth)

Production

Refer also to abstract 54830.

54800 (AEC-tr-7350) ACCUMULATION OF RESIDUAL GAS IONIZATION PLASMA IN AN ELECTROMAGNETIC TRAP. Pankrat'ev, Yu. I.; Nozrachev, M. G.; Lavrent'ev, O. A.; Safronov, B. G.; Naboka, V. A.; Ponomarenko, E. F. Translated from At. Energ. (USSR); 32: No. 2, 131-6(1972). 14p. Dep. NTIS.

An abstract of this paper, prepared from the original language, appeared as NSA 26: 22008. (M.O.W.)

54801 (CEA-CONF-2049) ANALYSIS OF THE MULTICHARGED HEAVY IONS PRODUCED BY LASER IMPACT ON A METALLIC TARGET. APPLICATION TO THE CONSTRUCTION OF A SOURCE. Perez, A. (Commissariat a l'Energie Atomique, Limeil-Brevannes (France). Centre d'Etudes). 1972. 11p. (In French). (CONF-720120-4). Dep. NTIS (U. S. Sales Only).

From Conference on the sources of multicharged ions; Paris, France (28 Jan 1972).

The spectral characteristics of the plasma created by laser impact on a heavy target were determined. The characteristics of the ion emission (directivity, dependence on the wavelength) were also studied. Tentative extraction and acceleration experiments were also performed. (France)

54802 ION ENERGIES IN A LASER-PRODUCED PLASMA. Bykovskii, Yu. A.; Degtyarev, V. G.; Degtyarenko, N. N.; (and others) (Moscow Engineering-Physics Inst.). Sov. Phys.-Tech. Phys. (Engl. Transl.); 17: No. 3, 517-20(Sep 1972).

Translated from Zh. Tekh. Fiz.; 42: No. 3, 658-61(Mar 1972).

The maximum energy E_{max} of the ions in a laser-produced plasma was measured as a function of the radiation flux density over the range $q \sim 10^8$–10^{11} W/cm^2. A dependence of E_{max} on the ion mass was found. The function $E_{max} = f(q)$ is relatively weak in the range 10^8 to 10^9 W/cm^2. The integrated spectrum is found from the energy distribution of ions with different charge multiplicities. (auth)

54803 SELF-IGNITING PULSED OPTICAL DISCHARGE IN AN EROSIVE LASER PLASMA. Goncharov, V. K.; Poparev, A. N.; Min'ko, L. Ya. (Inst. of Physics, Minsk). Zh. Eksp. Teor. Fiz.; 62: No. 6, 2111-14(Jun 1972). (In Russian).

A pulsed optical discharge at atmospheric pressure was obtained for the first time at the focus of a lens with a radiation flux of 10^7 to 10^8 W/cm^2, the discharge being ignited by an erosive plasma produced by the laser radiation incident on absorbing materials. The burning peculiarities of the self-igniting pulsed optical discharge were studied. The electron density is estimated to be $\sim 2 \times 10^{17}$ cm^{-3} and excitation temperature ~22,000°K on the basis of spectroscopic investigations of the discharge plasma. (auth)

54804 NANOSECOND AND PICOSECOND LASER-PRODUCED CD_2 PLASMAS. Olsen, J. N.; Jones, E. D.; Gobeli, G. W. (Sandia Labs., Albuquerque, N. Mex.). J. Appl. Phys.; 43: No. 10, 3991-9(Oct 1972).

A preliminary comparison is made of plasmas created by irradiation of CD_2 slab targets by single high-energy Nd^{3+} glass laser pulses of 3.5-nsec (35 J max) and 3 to 10-psec (10 J max) duration. For the nanosecond irradiation one finds electron temperatures of 350 to 400 eV and appreciable C^{5+} ions at 20-keV expansion energy. Ion expansion energies for a picosecond pulse are about one-third those for a nanosecond irradiation of comparable energy. Up to 50% of the incident pulse energy may be accounted for in plasma expansion in either case. In each case, the specularly reflected energy back into the input f/5.0 lens is small: 0.4% and 0.8% for the nanosecond and picosecond times, respectively. Detailed ion analysis shows the target composition to be $CD_{2-x}H_x$, where $0.2 < x < 0.9$ with traces of oxygen also observable. (auth)

Stability

54805 (CONF-720705-4) OBSERVATION OF A PARAMETRIC INSTABILITY NEAR THE LOWER HYBRID FREQUENCY. Hooke, W. M.; Bernabei, S. (Princeton Univ., N. J. Plasma Physics Lab.). [nd]. Contract AT(11-1)-3073. 8p. Dep. NTIS.

From 1st topical conference on rf plasma heating; Lubbock, TX. (6 Jul 1972).

A parametric instability was observed at frequencies close to and somewhat above the lower hybrid resonance frequency. The threshold for this decay occurs when the rf electron drift velocity is of the order of the ion sound speed. (auth)

54806 (CONF-720804-6) TOROIDAL EFFECTS ON MHD STABILITY IN TOKAMAKS. Weimer, K. E.; Johnson, J. L.; Greene, J. M.; Frieman, E. A. (Princeton Univ., N. J. Plasma Physics Lab.). [nd]. Contract AT(11-1)-3073. 4p. Dep. NTIS.

From 5th European conference on controlled fusion and plasma physics; Grenoble, France (21 Aug 1972).

Toroidal effects on MHD flute, ballooning, and kink modes are examined in an expansion in the inverse aspect ratio a/R, and stability criteria are found. (auth)

54807 (COO-3497-2) ANNUAL PROGRESS REPORT. Simon, Albert (Rochester Univ., N. Y.). 15 Sep 1972. Contract AT(11-1)-3497. 9p. Dep. NTIS.

A mirror-flute instability analysis was carried through in both the quasi-linear and nonlinear limits in slab and cylindrical geometry. Explosive instability occurs only if one includes "non-constant" gravity in the equations of motion. The analysis for collisional drift instability was carried through in both quasi-linear and nonlinear limits in slab geometry for constant electron temperature. Brief summaries of the above work are given. (M.O.W.)

54808 (LRP-51/72) TRANSVERSE DYNAMIC STABILIZATION OF A THETA PINCH. Lister, G. G.; Troyon, F. S.; Weibel, E. S. (Centre de Recherches en Physique des Plasmas, Lausanne (Switzerland)). Jun 1972. 33p. Dep. NTIS (U. S. Sales Only).

The stability of a straight plasma column confined by a static axial magnetic field and a small oscillating transverse magnetic field is discussed. Growth rates for the most important parametric instabilities are obtained. The influence of damping in providing a stabilizing mechanism against these instabilities is discussed, and a set of stability criteria are obtained using a viscous fluid model for the plasma. The possibility of suppressing the fastest growing instability by "wobbling" the frequency of the applied field is also discussed. An order-of-magnitude calculation for dynamic stabilization of a toroidal plasma is presented. (auth)

54809 (NP-19406) EXCITATION BY VERY HIGH FREQUENCY WAVE PUMPING OF PARAMETRIC INSTABILITIES IN A MAGNETOACTIVE PLASMA. Andreev, H. E.; Batanov, G. M.; Sarksyan, K. A. (Akademiya Nauk SSSR, Moscow. Fizicheskii Institut). 1972. 17p. (In Russian). Dep. NTIS (U. S. Sales Only).

Nonthermal radiation from magnetoactive plasma was experimentally investigated while the plasma was interacting with a vhf wave, the frequency ω_0 of which was greater than the electron Langmuir frequency ω_L but less than the electron cyclotron frequency. Radiation at a displaced frequency, relative to ω_0, was detected in the direction of smaller frequencies on the order of ion-acoustic vibrations. A dependence of plasma density on radiation intensity at the second harmonic of the vhf pumping wave was investigated. The relation of the observed radiation to the development of a parametric instability was discussed. (tr-auth)

54810 LINEAR THEORY OF CURRENT-DRIVEN PLASMA INSTABILITIES. Sizonenko, V. L.; Stepanov, K. N. (Physical-Technical Inst., Kharkov). Sov. Phys.-Tech. Phys. (Engl. Transl.); 17: No. 3, 385-8(Sep 1972).

Translated from Zh. Tekh. Fiz.; 42: No. 3, 484-9(Mar 1972).

If the electrons move with respect to the ions with a velocity appreciably greater than the electron thermal velocity, oscillations can be excited in which resonant electrons and ions participate. The growth rates are of the same order as those for coherent excitation of MHD instabilities. (auth)

54811 NONLINEAR ELECTRON-CYCLOTRON DRIFT INSTABILITY. Biskamp, D.; Chodure, R. (Max-Planck-Institut fuer Plasmaphysik, Garching, Ger.). Nucl. Fusion; 12: No. 4, 485-7 (Jul 1972).

A simple model was used to investigate the dependence of the growth rate of the electron-cyclotron drift instability on parameters such as drift velocity over thermal velocity, and the magnetic field strength given by the ratio Ω_e/ω_{pe}. The results are compared to one-dimensional calculations. (M.O.W.)

54812 DISSIPATIVE INSTABILITY DUE TO SUPERSONIC MOTION OF IONS WITH RESPECT TO NEUTRALS. Stakhanov, I. P. Sov. Phys.-Tech. Phys. (Engl. Transl.); 17: No. 3, 396-401(Sep 1972).

Translated from Zh. Tekh. Fiz.; 42: No. 3, 500-7(Mar 1972).

A dissipative instability in a weakly ionized plasma due to collisions with neutrals is analyzed; hydrodynamic supersonic flow with friction between charged and neutral components in a plasma is also analyzed. If the plasma velocity, with respect to the neutrals, exceeds the ion-acoustic velocity, an instability develops. In the initial stage the growth rate is proportional to the frequency of ion-neutral collisions; the instability disappears in the absence of such collisions. The change in the character of the large-scale flow due to the instability is evaluated in the quasi-linear approximation. (auth)

54813 MAGNETOHYDRODYNAMIC AND TEARING INSTABILITIES IN A TOKAMAK. Amano, Tsuneo (Osaka Univ.); Wakatani, Masahiro; Watanabe, Masami. J. Phys. Soc. Jap.; 33: No. 3, 782-8(Sep 1972).

The stability of a current-carrying plasma in a strong longitudinal magnetic field, such as in Tokamak-type devices, against the MHD and tearing instability is investigated. The growth rates of the MHD instability are computed numerically as eigenvalues of the equation of motion for several current distributions. The influence of the position of the conducting shell on the stability is also investigated. (auth)

54814 DETERMINATION OF THE MAGNETIC FIELD B IN VACUUM FOR GENERAL TWO-DIMENSIONAL MHD EQUILIBRIA. Kerner, W.; Pfirsch, D.; Tasso, H. (Max-Planck-Institut fuer Plasmaphysik, Garching, Ger.). Nucl. Fusion; 12: No. 4, 433-5 (Jul 1972).

For general two-dimensional MHD-equilibria it is possible, by using complex functions, to obtain the solution of the vacuum magnetic field which fits the boundary conditions at the plasma surface. The solution allows a distinction between the geometry-governed and the plasma-magnetic-field-governed singularities and stagnation points. Several examples, particularly the elliptic-plasma-boundary case, are discussed. (auth)

54815 PLASMA EQUILIBRIUM IN CONFIGURATIONS WITH A HELICAL MAGNETIC AXIS WITH ALLOWANCE FOR TOROIDALITY. Aleksin, V. F.; Shishkin, A. A. (Physical-Technical Inst., Kharkov). Nucl. Fusion; 12: No. 4, 437-43(Jul 1972).

Plasma equilibrium is studied in Vintotrons toroidal traps with a spatial magnetic axis established by various combinations of magnetic fields from helical conductors. The displacement of the vacuum magnetic axis is determined in the presence of a plasma as a function of the relationship between the curvature of the helical magnetic axis, the curvature of the torus, and a parameter characterizing the ellipticity of the vacuum magnetic surfaces. The limiting equilibrium values of $\beta = 8\pi P_0/B_\delta^2$ are determined from the displacement of the magnetic axis. Characteristic equilibrium values of β are compared for Vintotrons and stellarators. The possible effects of resonance phenomena that can occur in a toroidal Vintotron in the presence of a plasma are also discussed. (auth)

54816 LONG-WAVE INSTABILITY CAUSED BY INHOMOGENEOUS ION BEAMS IN A DENSE MAGNETIZED PLASMA. Goncharov, A. A.; Pashitskii, E. A. (Inst. of Physics, Kiev). Sov. Phys.-Tech. Phys. (Engl. Transl.); 17: No. 3, 418-23 (Sep 1972).

Translated from Zh. Tekh. Fiz.; 42: No. 3, 528-35(Mar 1972).

A longwave surface-wave instability is investigated in a system of spatially inhomogeneous ion beams moving along the magnetic field in a dense plasma. In the frequency range $\omega_{Hi} \ll \omega \ll \omega_{He}$ and the velocity range $c_s \ll V_0 \ll V_e$ a density inhomogeneity $n_0(x)$ or a velocity inhomogeneity $V_0(x)$ can cause a gradient-driven instability. (auth)

54817 ELECTROSTATIC INSTABILITY OF A HOT-ELECTRON PLASMA IN A HIGH-FREQUENCY FIELD. Klopovskii, K. S. Sov. Phys.-Tech. Phys. (Engl. Transl.); 17: No. 3, 441-7(Sep 1972).

Translated from Zh. Tekh. Fiz.; 42: No. 3, 558-67(Mar 1972).

Intermittent microscopic instabilities are frequently observed in experiments on the heating of an electron plasma by a high-frequency field. A theoretical discussion of this instability is given on the basis of a model incorporating the features of the experimental situation. An electron plasma is assumed to have a cold component and a hot component. The cold component is uniformly distributed throughout the volume of a cylindrical resonator and has a density greater than that of the hot component. The hot electrons are trapped in the high-frequency field excited in the resonator and perform anharmonic oscillations about the minimum of U_{hf}, where U_{hf} is the effective potential associated with the hf field. Under these conditions the interaction of the cold electrons with the trapped hot electrons can lead to the development of an electrostatic instability in the cold

plasma. The instability is similar to the negative mass instability. The instability appears at the cyclotron frequency and the plasma frequency. (auth)

54818 TRANSVERSE INSTABILITY OF HOT-ELECTRON PLASMA IN A CYLINDRICAL RESONATOR. Klopovskii, K. S. Sov. Phys.-Tech. Phys. (Engl. Transl.): 17: No. 3, 448-55 (Sep 1972).

Translated from Zh. Tekh. Fiz.; 42: No. 3, 568-77(Mar 1972).

The microinstabilities associated with the heating of an electron plasma by a high-frequency field in a cylindrical resonator are studied. The resonator is assumed to contain a low-density hot electron plasma confined by the hf field. Under certain conditions, transverse instabilities can occur at frequencies $l\Omega + n\omega_0$ (Ω is the Larmor frequency and ω_0 the axial bounce frequency of the electrons). The strongest instabilities are the E mode ($H_z = 0$), in the direction $k_\perp^2/k_\parallel^2 > l^2\Omega^2/n^2\omega_0^2 \gg 1$. The instability is similar to the negative-mass instability. The influence of the electron energy distribution on the instability is analyzed. (auth)

54819 INSTABILITY CONTROL IN A BEAM-PLASMA SYSTEM. Udovichenko, Yu. K.; Leont'ev, N. I.; Timoshenko, A. P. Sov. Phys.-Tech. Phys. (Engl. Transl.); 17: No. 3, 477-81(Sep 1972).

Translated from Zh. Tekh. Fiz.; 42: No. 3, 605-11(Mar 1972).

The excitation of low-frequency (ion-acoustic, relaxation) and high-frequency oscillations in a beam-plasma system was studied experimentally. Excitation is controlled by varying the potential of an electrode inserted into the plasma. The instabilities can be controlled by applying relatively low positive potentials to the electrode. (auth)

54820 SYNCHROTRON INSTABILITY FOR PLASMA WAVES. Goreva, T. A.; Suvorov, E. V. (Gorky Radiophysical Research Inst., USSR). Zh. Eksp. Teor. Fiz.; 62: No. 6, 2147-55(Jun 1972). (In Russian).

The conditions of existence in a magnetoactive plasma of longitudinal waves with a phase velocity close to that of light are obtained. The increments of such waves during synchrotron instability due to the presence of isotropically distributed relativistic particles are determined and investigated. It is shown that the increments of the longitudinal waves considerably exceed those of the transverse wave instability appearing for the same parameters of the medium. (auth)

54821 NONLINEAR STABILIZATION OF BEAM INSTABILITY. Demchenko, V. V.; El-Siragy, N. M. (Atomic Energy Establishment, Cairo). Phys. Lett.; 41A: No. 2, 132-4(11 Sep 1972).

If a high-frequency field affects the dielectric properties of the plasma, it can be shown that this results in a dependence of the frequency of natural plasma oscillations on the field amplitude. So, the beam and the excited waves get out of resonance, the instability weakens and sometimes may totally vanish. (auth)

54822 INSTABILITY OF SPATIALLY SEPARATED PLASMA BEAMS. III. Bogdanov, E. P.; Orlov, L. K.; Romanov, Yu. A. (Gorky State Univ., USSR). Izv. Vyssh. Ucheb. Zaved., Radiofiz.; 15: No. 4, 521-7(1972). (In Russian).

The two-stream instability of spatially separated plasma beams of finite thickness is examined in a quasi-hydrodynamic approximation. It is shown that, if the beams have finite thickness, the instability region is limited both by small and large drift velocities. A minimum drift velocity at which the instability occurs may be smaller than the corresponding value in semi-bounded beams. The maximum of the increment of amplified waves decreases with decreasing layer thickness. The influence of the dielectric sublayer between the beams on the instability is studied. (tr-auth)

54823 DYNAMIC STABILIZER FOR PLASMA INSTABILITIES TO IMPROVE PLASMA CONFINEMENT AND TO INCREASE PLASMA DENSITY. Hendel, Hans W.; Tsu-kai, Chu; Simonen, Thomas C. (to United States Atomic Energy Commission). U. S. Patent 3,668,066. 6 Jun 1972. Filed 18 Feb 1970.

Method and apparatus are described for dynamic stabilization of plasma instabilities for improving plasma confinement and for increasing plasma density independent of the phase of the instabilities. The method comprises confining the plasma column between ionizing plates which supply energetic particles to the plasma in a direction parallel to the axis of the plasma column and interacting the plasma in a predetermined direction with externally supplied radio-frequency fields having a selectively variable power level amplitude and a sufficiently high frequency range. (auth)

Thermonuclear Processes

Refer also to abstract 53085.

54824 (AEC-tr-7334) EXPERIMENTAL DETERMINATION OF THE BASIC CHARACTERISTICS OF SPACE-PERIODIC MAGNETIC CONFIGURATIONS. Loktionov, Yu. M.; Sebko, V. P.; Tyupa, V. I. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). Translation of report KHFTI-70/49. 11p. Dep. NTIS.

The specific features of magnetic configurations with the spatial magnetic axis of the "vintotron," "vintotors" and "asymmetrical stellarator" types often do not permit the use of the method employed for systems with a plane magnetic axis ("stellarator," "torsatron") for investigating the magnetic fields by means of electron beams. A certain modification of such a method, however, described in this work, makes it possible to investigate experimentally several important characteristics of configurations exhibiting a helical magnetic axis. Experimentally investigated herein are the structures of magnetic surfaces, position of spatial magnetic axes, angles of rotational transformation and shear in the single-pass "vintotron" and double-pass "vintotors," which are used herein as examples. (auth)

54825 (CLM-R-116) USE OF LIQUID LITHIUM AS COOLANT IN A TOROIDAL FUSION REACTOR. PART II. STRESS LIMITATIONS. Hancox, R.; Booth, J. A. (United Kingdom Atomic Energy Authority, Abingdon (England). Culham Lab.). Nov 1971. 10p. Dep. NTIS (U. S. Sales Only). UK 50 pence.

The pressure gradient induced in liquid lithium as it is pumped across a magnetic field was calculated in Part I of this report. The stress in the walls of the lithium ducts due to this pressure is shown to limit the wall loading in a toroidal reactor, and this limitation is seen to be more severe than the need to restrict the pumping power. A stress criterion is developed and then applied to both a low-power prototype reactor and a large commercial reactor. It is shown that, although the use of the lithium for cooling the nuclear blanket is possible in the former, it leads to an economically unattractive power density in the commercial reactor. (auth)

54826 (CONF-720901-(Bks.1 and 2), pp 559-73) NEUTRON AND GAMMA PHYSICS PROBLEMS IN FUSION REACTORS. Maynard, C. W.; Abdou, M. A. (Univ. of Wisconsin, Madison). 1972.

From Meeting on new developments in reactor physics and shielding calculations; Kiamesha Lake, NY. (12 Sep 1972).

The discussions and results presented here apply to a fusion reactor classified as a D-T fueled low-β toroidal system. However, most of the paper will apply almost equally well to other systems. A low-β toroidal reactor will confine the plasma in a torus surrounded by a coolant and lithium bearing region called the blanket and followed by a shield. The magnet coils are outside this and will be superconducting to achieve the large fields required. Various fueling and exhaust ports breach the blanket and shield and coolant passages must pass between magnet windings. Neutron absorptions in lithium provide the tritium production for fuel breeding. The results of importance for reactor design fall into the following categories. The helium, proton, and atom displacement production rates are important in evaluating radiation damage problems. The (n,2n) reaction rates as well as the ^{6}Li and ^{7}Li tritium production rates influence the tritium breeding ratio. The energy deposition rate by the neutrons and the resulting gammas provide the basic input for heat removal studies. Activation of structural and other materials is important for decay heat and hazards studies; and leakage from the shield determines the heat load to the refrigeration system for the superconducting magnets. (M.O.W.)

54827 (IPP-4/97) LITHIUM AND FLIBE AS COOLANTS FOR FUSION REACTOR BLANKETS. Daenner, W. (Max-Planck-Institut fuer Plasmaphysik, Garching (West Germany)). Jun 1972. 22p. (In German). Dep. NTIS (U. S. Sales Only).

Lithium and flibe which were both proposed as coolants for thermonuclear reactor blankets are different not only in view of their neutronic behavior but also in view of their thermohydraulic properties. The thermal properties of both coolants are summarized and compared with those of sodium. The heat-transport properties appear superior to those of sodium. The influence of strong magnetic fields on the flow conditions and the heat transfer characteristics are pointed out. Pumping losses and pumping power prove to be of mainly hydrodynamic nature in the case of flibe, whereas they are essentially determined by MHD-pressure losses in the case of lithium and sodium. The differences of temperature and pressure-drop characteristics in a cooling channel are discussed for the case of coupling it to a steam thermal power cycle. (auth)

54828 (LA-DC-72-896) SURVEY OF SCYLLAC EXPERIMENTS. Burnett, S. C.; Ellis, W. R.; Gribble, R. F.; (and others)

(Los Alamos Scientific Lab., N. Mex.). [nd]. 12p. (CONF-720804–7). Dep. NTIS.

From 5th European conference on controlled fusion and plasma physics; Grenoble, France (21 Aug 1972).

"Scyllac" research is currently divided among three major experimental efforts: (a) the 5-meter 120° toroidal sector, (b) a 5-meter linear theta pinch with strong end mirrors, and (c) a feedback stabilization experiment on Scylla IV-3. In the sector the toroidal force and outward plasma drift are compensated by a combination of l = 1 helical fields and l = 0 bumpy fields. A period of equilibrium on the toroidal axis is followed by sideward motion of the plasma column, predominantly in the plane of the torus, that could either be an imbalance between the l = 1,0 and toroidal forces or a long-wavelength m = 1 instability. Containment times up to 11 μsec, comparable to times for plasma end loss, have been observed. Without mirrors the linear device produces a 2- to 3-keV plasma that shows a "wobble" of up to 1.5-cm amplitude, but otherwise remains centered more than 35 μsec (~3 e-folding times for end loss). With simultaneously applied mirror fields of 2.5 mirror ratio, the plasma column shows evidence of an m = 1 instability that carries it to the wall at some point along its length early in time. However, the column re-forms and the neutron yield is larger than without mirrors for the entire plasma lifetime. In the feedback experiment, l = 0 windings are driven by a power amplifier from a signal generated by plasma displacement as determined by an optical sensor. Initial results confirm feasibility of the feedback concept. (auth)

54829 (ORNL-TM-3953) SUMMARY OF ENGINEERING DESIGN OF MAGNET SYSTEMS FROM INTERNATIONAL WORKING SESSION ON FUSION REACTOR TECHNOLOGY. Lubell, M. S. (Oak Ridge National Lab., Tenn.). Sep 1972. Contract W-7405-eng-26. 51p. Dep. NTIS.

The emerging importance of superconducting magnet systems not only for fusion reactors but also for fusion research was clearly indicated by the great number of papers presented at this session. There were twenty-four talks, including two state-of-the-art reviews, and thus this summary will attempt to provide a general overall impression of the session without reviewing each contribution in depth. An appendix follows listing the topics and speakers in order of presentation and a short abstract which most of the participants provided for their contribution. Many subjects were discussed and various problems mentioned. The major problems raised and still to be investigated for very large-scale systems are: (1) superconducting material cost, particularly for high fields, (2) large-bore high-field magnets, (3) superconducting instabilities in magnets not completely stabilized, (4) structural problems associated with static and dynamic force containment, (5) switches for inductive energy-storage devices and also persistent switches for superconducting magnets, (6) protection of superconducting magnet systems, including dewars, and structural members against a sudden quench, and (7) refrigeration and field-erected vacuum systems. (auth)

54830 FUSION BY LASER-DRIVEN FLAME PROPAGATION IN SOLID DT TARGETS. Bobin, J. L.; Colombant, D.; Tonon, G. (Centre d'Etudes de Limeil, Villeneuve-Saint-Georges, France). Nucl. Fusion; 12: No. 4, 445-52(Jul 1972).

When a laser light flux ϕ impinges on a solid target, a radiation wave propagates that transforms the material into a hot plasma. The structure of the hot parts is known to show an overdense hot stationary deflagration structure followed by a nearly isothermal rarefaction. The temperature T of the hot plasma varies as $(\phi/n_{ec})^{\frac{1}{3}}$, n_{ec} being the cutoff density. Then the ratio of the energy of the thermonuclear reaction products to the sum of the radiated energy plus the (kinetic + thermal) energy in the plasma is readily calculated for DT as a function of the duration of the interaction. For a 30% efficiency of the energy-conversion cycle, typical figures for a positive energy balance are $\phi = 5 \times 10^{14}$ W/cm^2 (T = 10^8°K), $\tau = 10^{-7}$ s for Nd glass, and $\phi = 5 \times 10^{12}$ W/cm^2 (T = 10^6°K), $\tau = 10^{-5}$ s for CO_2 laser. For both cases, the required laser energy density is a few 10^7 joules/cm^2. In the latter case, a megagauss confining field could be successfully used to maintain a one-dimensional flame-propagation geometry. (auth)

54831 THERMONUCLEAR HOT SPOT. Somon, J. P. (EURATOM–CNEN, Frascati, Italy). Nucl. Fusion; 12: No. 4, 461-74 (Jul 1972).

The expansion of a spherical hot-spot within an infinite D–T medium is examined and the production of thermonuclear energy is calculated through the numerical solution of the plasma-fluid equations in a number of cases. Two kinds of hot-spots are considered in which the ions are initially either hot (ionic H-S) or cold (electronic H-S). The conditions for a positive energy balance and the ignition of a thermonuclear reaction wave are derived. At solid-state density a pulsed fusion reactor requires an energy of 10^3 to 10^4 MJ. Extensions are made to plane and cylindrical H-S and the expansion of a spherical H-S in vacuum. The thermonuclear output is not improved by progressive H-S heating or a decrease in thermal conductivity in a transverse magnetic field. (auth)

54832 INFLUENCE OF TOROIDALITY ON A MAGNETIC CONFIGURATION WITH A HELICAL MAGNETIC AXIS. Aleksin, V. F.; Nemov, V. V.; Shishkin, A. A. (Physical-Technical Inst., Kharkov). Nucl. Fusion; 12: No. 4, 411-17(Jul 1972).

The changes that occur in a configuration with a helical magnetic axis upon bending to form a torus are investigated. Such a magnetic configuration can be created by various combinations of magnetic fields produced by helical conductors. In the calculations it is assumed that the pitch of the helical winding and the radius of the circular axis of the torus are significantly greater than the minor radius of the torus. This means that $\delta = b/R \ll 1$ and $\epsilon = lb/R \ll 1$, where b and R are, respectively, the minor and major radii of the torus and l is the number of turns of the helical conductor around the torus. Toroidality is regarded as a perturbation superposed on the configuration with a helical magnetic axis. The conditions under which the helical magnetic axis breaks down are considered. The distance to which the resulting magnetic axes move away from the magnetic axis of the unperturbed configuration is indicated approximately. (auth)

54833 CONDITIONS FOR QUASI-STEADY DEVELOPMENT OF SELF-SUSTAINING NUCLEAR REACTIONS. Kolesnichenko, Ya. I. (Inst. of Nuclear Research, Kiev). Nucl. Fusion; 12: No. 4, 419-22(Jul 1972).

The conditions in which quasi-steady operation of a thermonuclear reactor is possible are investigated. The examination is based on the equation for the energy balance of a deuterium–tritium plasma layer in which thermonuclear reactions are occurring. It is assumed that the principal energy losses from the system are due to thermal conductivity of the plasma and to bremsstrahlung. It is shown that quasi-steady operation of a thermonuclear reactor requires certain limitations on the transverse plasma dimension L. When this dimension exceeds a critical value L_{max} there will occur self-acceleration of the thermonuclear reactions and self-heating of the plasma, which in the initial stage are similar to a thermal explosion. If $L < L_{min}$, the energy lost from the system will exceed the energy released in it and the thermonuclear reaction will be extinguished. The quantities L_{max} and L_{min} are determined by the transverse transport coefficients of the plasma and by the boundary conditions. The temperature distributions in the plasma layer are found. The stability of these distributions is studied. It is concluded that steady states are unstable in systems with a low boundary temperature. (auth)

54834 MEGAGAUSS PHYSICS. Latal, Heimo G. (Univ., Graz). Acta Phys. Austr.; 34: No. 1-2, 65-82(1971). (In German).

The production of megagauss magnetic fields is reviewed. The various methods with their limitations are discussed, especially the implosion method. In addition to flux compression using explosions as triggers, an interesting variation—electromagnetic compression—is also presented. Findings in megagauss fields are analyzed with respect to such effects as Zeeman's, Faraday's and conductivity. Also discussed are special application of megagauss fields for the study of high-energy quantum-electrodynamic effects. (34 references) (H.B.G.)

54835 POLYGONAL ASTRON REACTOR FOR PRODUCING CONTROLLED FUSION REACTIONS. Christofilos, Nicholas C. (to United States Atomic Energy Commission). U. S. Patent 3,668,067. 6 Jun 1972. Filed 16 Oct 1969.

An Astron reactor is described that includes a plurality of linear magnetic field regions joined by intervening curved magnetic fields and arranged in a polygonal configuration. Energetic charged particles are introduced and trapped in the linear sections to form cylindrical sheaths, i.e., E layers, of charged particles rotating about the axis of each section with the magnetic field thereof interacting with the linear magnetic regions to produce a closed system of magnetic-field lines defining a containment zone for charged particles. Fuel materials introduced into the field are ionized and heated to form a high-temperature plasma trapped in the said zone. The ratio of the lengths of the linear and curved-field regions is regulated to offset Bohm diffusion losses. A high molecular weight initiator plasma may also be introduced to heat the fuel to fusion temperatures. (auth)

Wave Phenomena

Refer also to abstract 54792.

54836 (AEC-tr-7331) GENERATION OF FAST ELECTRONS THROUGH INTERACTION OF SHF WAVE WITH COLLISIONLESS PLASMA. Bariyaov, V. I.; Gekker, I. R.; Sizukhin, O. V.; Khachaturan, Z. G. (Akademiya Nauk SSSR, Moscow. Fizicheskii Institut). Translation of report NP-18958. 7p. Dep. NTIS.

An investigation was carried out in order to determine whether or not fast electrons are generated during observation of anomalous absorption of shf waves in collisionless plasma. The plasma flow is produced by a spark injector (hydrogen–carbon plasma). (auth)

54837 (AEC-tr-7333) EXCITATION OF ELECTROMAGNETIC WAVES IN A PLASMA BY A RELATIVISTIC ELECTRON BEAM. PART I. LONGITUDINAL WAVES. Rukhadze, A. A.; Bogdankevich, L. S.; Dolzhenko, O. V. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). Translation of report NP-18982. 21p. Dep. NTIS.

A metal waveguide of radius R is filled with a plasma through which a relativistic electron beam with radius $r < R$ passes. The hydrodynamic equations are given for a collision-free, cold plasma contained by an external longitudinal magnetic field B which is greater than the beam current field. On linearizing this set of equations for small deviations from a stationary equilibrium state, a partial differential equation is obtained for the perturbed field potential. The conditions for beam instability and cyclotron instability are explored over a rather narrow range of high-frequency plasma oscillations for the case of $r = R$. The conditions for long- and short-wave oscillations are also given at $r < R$. A discussion is presented on the production of radiation in the region of wavelengths $l = 10^{-1}$ to 3 cm on interaction of a 1-MeV electron beam with a plasma having a particle density of 10^{10} to 10^{12} particles/cm^3. (TTT)

54838 (AEC-tr-7335) ON THE THEORY OF TRANSFORMATION OF SURFACE WAVES INTO LONGITUDINAL OSCILLATIONS IN THE SURFACE LAYER OF A PLASMA WAVEGUIDE. Demchenko, V. V.; Dolgopolov, V. V.; Omel'chenko, A. Ya. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). Translation of report KHFTI-70-55. 12p. Dep. NTIS.

It is shown that surface waves caused by perturbation in a homogeneous plasma cylinder during the interval of time determined by the width of the narrow transition region from plasma to vacuum, are converted to longitudinal oscillations concentrated in the plasma–vacuum transition layer and propagating along the plasma density gradient (radially). (auth)

54839 (AEC-tr-7336) EFFECT OF HIGH-FREQUENCY POTENTIAL ON PROPAGATION OF FAST WAVES ALONG A MAGNETOACTIVE PLASMA LAYER. Demchenko, V. V.; Dolgopolov, V. V.; Omel'chenko, A. Ya. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). Translation of report KHFTI-70-57. 9p. Dep. NTIS.

The effect of electromagnetic wave field pressure on the propagation of fast waves along a plane-parallel layer of magnetoactive plasma is investigated. Expressions are derived for the fields and dispersion equations are derived in limiting cases when the high-frequency potential is low or great compared with the plasma temperature. The dispersion equations differ substantially from the dispersion equations of linear theory. Plasma density distribution through layer thickness is determined. It is shown that high-frequency potential may assure penetration of the electromagnetic field into plasma, which in linear approximation does not penetrate into the plasma due to the skin effect. (auth)

54840 (AEC-tr-7337) ON THE EFFECT OF WAVE FIELD PRESSURE ON LONGITUDINAL OSCILLATIONS IN A PLASMA. Dolgopolov, V. V. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). Translation of report KHFTI-70-58. 4p. Dep. NTIS.

The effect of hf wave potential (electromagnetic wave field pressure) on Langmuir monochromatic oscillations in plasma is investigated. It is shown that the pattern of field oscillations, constructed with consideration of the high-frequency potential, differs substantially from that of oscillations in linear approximation even in the case when gas-kinetic pressure of the plasma is substantially higher than the electromagnetic field pressure. In particular, localized monochromatic standing waves are found to be possible. (auth)

54841 (AEC-tr-7338) CONDITIONS FOR WAVE TRANSFORMATION IN A PLASMA WITH A NONMONOTONIC LONGITUDINAL DISTRIBUTION. Arkhipenko, V. I.; Budnikov, V. N.; Obukhov, A. A. (Akademiya Nauk SSSR, Leningrad. Fiziko-Tekhnicheskii Institut). Translation of report NP-18913. 15p. Dep. NTIS.

The results of experimental studies and analysis of conditions for wave transformation in a plasma with a nonmonotonic longitudinal distribution are described. The plasma was formed in a homogeneous magnetic field at magnetic fields greater than the electron-cyclotron field $H > H_c = mc\omega/e$ under the action of superhigh-frequency power in the 10-cm wavelength range. The experimental conditions were: the working gas was argon at pressure of 10^{-1} to 10^{-3} mm Hg, the magnetic field was up to 3000 Oe, $n = 10^{11}$ to 10^{12} cm^{-3}, and $T_e = 2$ to 10 eV. (auth)

54842 (AEC-tr-7339) STUDY OF THE LOCALIZATION OF THE WAVE TRANSFORMATION REGION IN A SUPERHIGH-FREQUENCY DISCHARGE PLASMA. Arkhipenko, V. I.; Budnikov, V. N.; Obukhov, A. A. (Akademiya Nauk SSSR, Leningrad. Fiziko-Tekhnicheskii Institut). Translation of report NP-18912. 10p. Dep. NTIS.

The position of the wave transformation region in a plasma formed under the action of superhigh-frequency power of the 10-cm range was investigated. Experiments were carried out under magnetic fields smaller and greater than the electron cyclotron field, which corresponds to the high-frequency and middle regions of wave transformation in a plasma. The plasma was produced in a quartz cylinder 70 cm in length and 2.5 cm in diameter placed in a rectangular waveguide of the 10-cm range at argon pressures of 10^{-1} to 10^{-3} mm Hg. The position of the transformation region was determined with the aid of small local perturbations of the magnetic field leading to collapse of the discharge. The longitudinal distribution of light radiation was also measured. The characteristics of the position of the transformation regions and the longitudinal distribution are discussed on the basis of the conclusions of the theory of wave transformation in a plasma with a two-dimensional inhomogeneity. (auth)

54843 (AREAEE-124) PENETRATION OF TRAVELLING HIGH-FREQUENCY ELECTROMAGNETIC FIELD INTO A "NON-TRANSPARENT" PLASMA. Demchenko, V. V.; Hussein, A. M. (Atomic Energy Establishment, Cairo (Egypt). Dept. of Accelerators and Plasma Physics Research). 1971. 20p. Dep. NTIS (U.S. Sales Only).

The effect of the averaged force of a high-frequency field on the propagation of electromagnetic waves by external harmonic currents is investigated in bounded plasma configurations. The account of high-frequency pressure is shown to result in the following: the plasma which was "non-transparent" for waves in a linear approximation (with no account of high-frequency pressure) becomes "transparent" or, in the nonlinear approximation, the waves can penetrate into the plasma if the field is skinned in the linear approximation. (auth)

54844 (AREAEE-125) THEORY OF PARAMETRIC EXCITATION OF OSCILLATIONS IN AN INHOMOGENEOUS PLASMA. Demchenko, V. V.; El-Naggar, I. A. (Atomic Energy Establishment, Cairo (Egypt). Dept. of Accelerators and Plasma Physics Research). 1971. 23p. Dep. NTIS (U. S. Sales Only).

Nonlinear effects that affect longitudinal oscillations of inhomogeneous plasma in the vicinity of plasma (hybrid) resonance points are investigated. The account of nonlinear terms due to plasma inhomogeneity in the equations of motion is shown to lead to the possibility of parametric buildup of oscillations at the subharmonic (harmonic) of the applied-field frequency. (auth)

54845 (CONF-720804-3) OBSERVATION OF NON-LINEAR EFFECTS NEAR THE LOWER HYBRID RESONANCE FREQUENCY. Hooke, W. M.; Bernabei, S. (Princeton Univ., N. J. Plasma Physics Lab.). [nd]. Contract AT(30-1)-1238. 4p. Dep. NTIS.

From 5th European conference on controlled fusion and plasma physics; Grenoble, France (21 Aug 1972).

Waves near the lower hybrid resonance frequency are electrostatically generated with plates just outside a cylindrical plasma column. These waves penetrate radially and, above a threshold power, are observed to undergo a parametric decay into two lower-frequency waves. (auth)

54846 (EUR-CEA-FC-639) THEORETICAL AND EXPERIMENTAL STUDIES OF ELECTRON PLASMA WAVE ECHOES. Guillemot, Michel (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Apr 1972. 220p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Univ., of Paris, France.

Electron plasma wave echoes are studied theoretically using a trajectory method. In this way, the disymmetric role played by the two parent waves producing the echo and saturation effects occurring when the amplitude of the second wave increases, are established. A deformation in the echo profile with variations in the second wave amplitude is predicted from the radial density profile and finite radial geometry considerations. Velocity space diffusion due to small-angle collisions produces a strong damping effect. Experimental results that are in good agreement with theoretical predictions enable the emitted-wave amplitude to be

established and lead to an order-of-magnitude estimation of the turbulent fields producing the diffusion. (France)

54847 DIFFRACTION OF AN ELECTROMAGNETIC WAVE AT A MAGNETOACTIVE PLASMA CYLINDER. Klavdiev, V. V. Radio Eng. Electron. Phys. (USSR) (Engl. Transl.); 16: No. 11, 1824-30(Nov 1971).

Translated from Radiotekh. Elektron.; 16: No. 11, 2048-55 (Nov 1971).

Using the energy method, i.e., from the work done by the field on the plasma particles, the absorption cross section of an ordinary electromagnetic wave is obtained for the normal incidence of the wave on a magnetized plasma cylinder for the model of mirror reflection of the particles at the plasma boundary. (auth)

54848 SCATTERING OF ELECTROMAGNETIC WAVES DUE TO ELECTRON CHARGE FLUCTUATIONS IN A FLAT WAVEGUIDE WITH A MAGNETOACTIVE PLASMA. Troitskii, S. V.; Yakimenko, I. P. Radio Eng. Electron. Phys. (USSR) (Engl. Transl.) 16: No. 11, 1968-70(Nov 1971).

Translated from Radiotekh. Elektron.; 16: No. 11, 2222-3 (Nov 1971).

A derivation is given for the noncoherent scattering cross section in a plane waveguide with a magnetoactive plasma for an arbitrary external magnetic field. (M.O.W.)

54849 LOW-FREQUENCY OSCILLATIONS IN THE WEAKLY IONIZED PLASMA OF A HIGH-FREQUENCY DISCHARGE IN A MAGNETIC FIELD. Shvilkin, B. N.; Blinova, T. L.; Postnikov, S. A. Radio Eng. Electron. Phys. (USSR) (Engl. Transl.); 16: No. 11, 1970-3(Nov 1971).

Translated from Radiotekh. Elektron.; 16: No. 11, 2224-5 (Nov 1971).

Tests were conducted in cylindrical glass tubes 100-cm long and with inside diameters of 2.5, 2.8, and 3.2 cm. A discharge was excited by means of a hf oscillator with a power of 400 W and a frequency of 6.6 MHz. Measurements showed that a buildup of drift oscillations occurs in the hf discharge at low pressures when the collision frequency of ions with neutral atoms is less than or of the order of the oscillation frequency. A description of the oscillations is given. (M.O.W.)

54850 METHOD FOR NONLINEAR PLASMA WAVE KINETICS. Tanaka, Takayasu (Kyoto Univ.). J. Phys. Soc. Jap.; 33: No. 3, 769-81(Sep 1972).

A new method is presented to investigate the nonlinear wave kinetics in a plasma. While most previous theories assume that the wave amplitudes and other average quantities vary very little within the duration time τ of the wave–wave interaction, the present theory is valid under much less restrictive condition that their variation is small in the oscillation periods of the waves under consideration. The method consists in a systematic use of the interaction representation; the unique point of the present method lies in the introduction of many time variables in order to describe phenomena with many physical quantities in a simple manner. The method is applied to the investigation of quasi-linear and weakly turbulent evolution of the system. Several new features, including the amplitude oscillation discussed in a previous report, are derived for the case where the characteristic time scale of the wave amplitude is short compared with τ. (auth)

54851 AUTOMODULATION OF ION OSCILLATION MODES IN PLASMA. Shimizu, Katsuya; Ichikawa, Yoshi H. (Nihon Univ., Tokyo). J. Phys. Soc. Jap.; 33: No. 3, 789-92(Sep 1972).

Automodulation of ion oscillation mode is investigated by applying the reductive perturbation theory to the fluid equation of a plasma composed of cold ions and isothermal electrons. It is shown that an oscillatory solution of the Korteweg–de Vries equation in the small-wave-number region satisfies a small-wave-number limit of the nonlinear Schroedinger-type equation obtained in the finite-wave-number region. (auth)

54852 SLIGHTLY OBLIQUE SHOCK WAVES IN A COLLISIONLESS MAGNETIZED PLASMA. Abe, Kanji (Tokyo Inst. of Tech.). J. Phys. Soc. Jap.; 33: No. 3, 793-6(Sep 1972).

Numerical computations for collisionless shock waves are carried out by using a simple model that retains the primitive but essential features of hot plasma. It is supposed that the direction of propagation of the wave is parallel or slightly oblique to the magnetic field ahead of the wave. For the case of low temperature and exactly parallel propagation, a train of solitary waves exists, and each of the solitary waves has a shape essentially identical with that of the solitary wave described by Saffman. The train of solitary waves, however, abruptly changes into a shock wave, when the direction of propagation becomes slightly oblique to the magnetic field. When the temperature is relatively high, only shock waves are found to exist for the case of exactly parallel as well as slightly oblique propagation. (auth)

54853 NONLINEAR SPACE-CHARGE WAVES IN A PLASMA SHEATH. Rutkevich, B. N.; Pashchenko, A. V.; Fedorchenko, V. D.; Muratov, V. I. (Physical-Technical Inst., Kharkov). Sov. Phys.-Tech. Phys. (Engl. Transl.) 17: No. 3, 391-5(Sep 1972).

Translated from Zh. Tekh. Fiz.; 42: No. 3, 493-9(Mar 1972).

In a thin plasma sheath, the field associated with the space-charge wave is essentially independent of the transverse coordinate and is proportional to the density oscillations. It is shown that simple waves and solitons can propagate in this sheath. Analysis of the oscillations in a beam–plasma system reveals a nonlinear limitation of the two-stream instability. (auth)

54854 STABILITY OF A MONOCHROMATIC WAVE AGAINST INDUCED SCATTERING. Blokh, Yu. P. (Physical-Technical Inst., Kharkov). Sov. Phys.-Tech. Phys. (Engl. Transl.); 17: No. 3, 389-90(Sep 1972).

Translated from Zh. Tekh. Fiz.; 42: No. 3, 490-2(Mar 1972).

The stability of a monochromatic longitudinal wave in a plasma is considered in two limiting cases: in the absence of an external magnetic field and in a strong field. The linear damping of the primary wave is small since its phase velocity satisfies $V_{ph} \gg V_{th}$, where V_{th} is the thermal velocity of the plasma particles. The principal mechanism leading to instability of the plasma wave is induced scattering. This is due to the resonant interaction of plasma particles with the beats that arise when the primary wave and the test wave with nearly equal frequencies ω_0 and ω interact. Beats with the difference frequency $\delta\omega = \omega - \omega_0$ have a phase velocity in the region of the thermal velocities. The instability of the test wave leads to transfer of energy to the long-wavelength part of the spectrum. The analysis considers the stability of a monochromatic wave at amplitudes $e\varphi_0/mV_{ph}^2 \gg V_{th}/V_{ph}$. (M.O.W.)

54855 TURBULENCE IN ELECTROSTATIC COLLISIONLESS SHOCK WAVES. Means, Robert William. Los Angeles; Univ. of California (1972). 90p. University Microfilms Order No. 72-22,171.

Thesis.

Ion-acoustic wave turbulence in collisionless electrostatic shock waves was observed and studied in a low-density unmagnetized dc discharge plasma produced in a DP machine. Shock waves were observed with amplitudes $0.05 \leq e\phi/T_e \leq 0.8$. Electron-to-ion-temperature ratios available were $5 \leq T_e/T_i \leq 50$. At low-temperature ratios ions were reflected from the shock wave and were measured by an electrostatic energy analyzer. If sufficient ions were reflected by the shock front, the plasma ahead of the front became unstable to the counterstreaming ions and turbulence developed in that region. The growth rates and spectra of the turbulence were measured, and qualitative agreement was found with a linear ion beam plasma theory. The three-dimensional character of the interaction of the beam with the plasma was very important. The turbulent waves must travel at angles to the reflected beam in order for their phase velocity to be resonant with the beam velocity. The density of reflected ions was also controlled at high-temperature ratios by the addition of small amounts of helium in an argon plasma. The light helium ions were the principal reflected component. Test waves were propagated ahead of the shock wave in order to measure growth rates as the reflected beam interacted with the test wave. The interaction of the reflected ion beam with the turbulence was studied by creating a steady-state ion beam in the plasma. The resulting decay of the beam was compared to a quasi-linear theory of a small resonant ion beam. Agreement between experiment and theory was found. The resultant shock wave model is an extension of the Moiseev–Sagdeev laminar model to include warm ions and the three-dimensional turbulence that results from the counterstreaming ion beam. (Diss. Abstr. Int., B)

54856 GENERATION OF BLAST WAVES IN A PLASMA BY A PULSED ELECTRIC DISCHARGE. Podol'skii, V. N.; Chutov, Yu. I. (Kiev State Univ.). Sov. Phys.-Tech. Phys. (Engl. Transl.); 17: No. 3, 502-4(Sep 1972).

Translated from Zh. Tekh. Fiz.; 42: No. 3, 638-41(Mar 1972).

Experiments were carried out in a glass electric shock tube (EST) with $\phi = 1.6$ cm; a moving interface is produced between argon, which fills the EST initially (0.74 mm Hg), and a mixture of argon and hydrogen; the interface moves at 2.2×10^4 cm/sec. The argon–hydrogen mixture is formed as a result of admission of hydrogen into the tube through a pulsed valve. In the expansion region of the EST a fixed plasma is produced by exponential discharge of a condenser. The temporal behavior of the argon and hydrogen lines is obtained from measurements at different points on the axis of the EST for different experimental conditions. The results show that the emission front formed in the plasma is a blast wave. (auth)

54857 LINEAR AND ALFVEN WAVES IN INCOMPRESSIBLE BEAM-PLASMA SYSTEMS. Verheest, Frank (Univ., Ghent). Int. J. Electron.; 33: No. 2, 201-7(Aug 1972).

The propagation of waves in incompressible beam–plasma systems is investigated on the basis of linear fluid equations. The pressure is assumed scalar and the incompressibility condition is chosen to illustrate a class of nonbarotropic plasmas. The dispersion law for these linear waves is derived, and is generally discussed. The case of oblique propagation differs appreciably from results obtained for barotropic plasmas, mainly because compressional longitudinal waves are absent. Alfvén waves in beam–plasma systems are then defined as low-frequency waves, with wave and drift frequencies small compared to gyrofrequencies. The Alfvén approximation of the dispersion law shows that the wave frequency at fixed wave-number is lower than if no streaming were applied. (auth)

54858 SOUND PROPAGATION IN IONIZED GASES AND ELECTRO ACOUSTIC EFFECT. Bhatnagar, V. P.; Bhatnagar, D. P.; Saxena, A. P. (Coll. of Engineering, Delhi). Int. J. Electron.; 33: No. 2, 193-200(Aug 1972).

Using hydrodynamical methods, the propagation of pressure waves in a nonisothermal fully ionized gas was considered for a situation where collision between various particles cannot be ignored and the following pressure equation was obtained: $(\partial^4 p/\partial t^4) + \nu_{el}(\partial^3 p/\partial t^3) - (V_e^2 + V_i^2)(\partial^2/\partial t^2)\nabla^2 p + \omega_e^2(\partial^2 p/\partial t^2) - \nu_{ei} V_i^2(\partial/\partial t)\nabla^2 p - \omega_e^2 V_i^2\nabla^2 p + V_i^2 V_e^2\nabla^4 p = 0$ where V_i^2, V_e^2, and V_i^2 represent respectively $(\gamma k T_i/m_i)$, $(\gamma k T_e/m_e)$, and $[\gamma k(T_i + T_e)/m_i]$ and other symbols have their usual meaning. This gives the following dispersion relation for a sinusoidal sound wave $V_i^2 V_e^2 k^4 - [V_e^2\omega^2 - (\omega_e^2 - i\nu_{ie}\omega)V_i^2]k^2 + [\omega^4 - (\omega_e^2 - i\nu_{ei}\omega)\omega^2] = 0$. The phase velocity of propagation and attenuation of the sound waves were discussed in the low frequency and high frequency region and it was shown that low frequency sound waves travel with a velocity V_i, while high frequency sound waves are carried by ions and electrons with velocities V_i and V_e respectively. Because of the difference in the masses of the ions and electrons, an electrostatic field of the same frequency as that of the sound is created during the propagation of sound waves. This field is given by: $E_0 = (e/\epsilon) \cdot (1/\gamma k T_e) \cdot (V/\omega)[(V_i^2/V^2) - 1]P_0$ and it is appreciable only at high frequencies where $V < V_i$. (auth)

54859 APPARENT CONSTANT-WAVELENGTH OSCILLATIONS IN A BOUNDED PLASMA. Keen, B. E.; Alcock, M. W.; Fletcher, W. H. W. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). Phys. Lett.; 41A: No. 2, 183-4(11 Sep 1972).

Constant-wavelength propagated oscillations are apparently observed in a bounded neon plasma column, in which a large-amplitude self-excited ion-sound instability is found to co-exist. A possible theoretical explanation is included. (auth)

54860 INFLUENCE OF COLLISIONS ON PLASMA-WAVE PROPAGATION NEAR ELECTRON GYROFREQUENCY HARMONICS. Krupina, A. E. (Scientific-Research Radiophysics Inst., Gorky, USSR). Izv. Vyssh. Ucheb. Zaved., Radiofiz.; 15: No. 4, 517-20(1972). (In Russian).

The transverse plasma-wave propagation in a magnetoactive plasma is considered near the electron gyrofrequency harmonics under the assumption that the wavelength is smaller than the gyroradius of an electron. In addition to relativistic effects, the collisions of electrons with other particles are taken into account. The dispersion equation derived is analyzed for particular cases of weak and strong collisions, as well as for the dependence on the resonance-frequency detuning. (tr-auth)

54861 VOLUME AND SURFACE WAVE TRANSFORMATION IN PLASMA SYSTEMS. Tolmachev, M. M.; Tseitlin, M. B. (Inst. of Radio Engineering and Electronics, Moscow). Izv. Vyssh. Ucheb. Zaved., Radiofiz.; 15: No. 4, 635-7(1972). (In Russian).

The transformation of a slow volume wave at the surface (and conversely) in a plasma cylinder with a spirally conducting surface was investigated. A continuous plasma concentration change was assumed in the direction of propagation. (K.S.W.)

54862 WAVE INTERACTIONS IN ANISOTROPIC PLASMA. Lolodze, Ts. D.; Khirseli, E. M. (Inst. of Physics, Tbilisi, USSR). Izv. Vyssh. Ucheb. Zaved., Radiofiz.; 15: No. 5, 647-51 (1972).

The processes of nonlinear interactions of high-frequency plasma waves with magnetohydrodynamic wave radiation in anisotropic plasma are considered. The particular cases of the helicon decay interactions with an acoustic wave in the partially ionized plasma and quasi-longitudinal waves with a magneto-acoustic wave in the fully ionized plasma are investigated. For the processes studied the increments of the wave increases are obtained, and the threshold values of the energy of the interacting waves are estimated. (tr-auth)

54863 NONLINEAR WAVE INTERACTIONS IN A CYLINDRICAL COLUMN OF MAGNETO-ACTIVE PLASMA. Kormilets, V. M.; Yakimenko, I. P. (Kharkov Inst. of Radio-Electronics). Izv. Vyssh. Ucheb. Zaved., Radiofiz.; 15: No. 5, 652-9(1972). (In Russian).

The coordinate presentation of the nonlinear current occurring at the interaction of a set of electromagnetic waves in a plasma cylinder placed in the constant magnetic field H_0 (0, 0, h_0) (cold plasma approximation) is obtained in the hydrodynamic approximation. The re-radiated field induced by this current is found on the basis of the reciprocity theorem for the gyrotropic medium. The results obtained are connected with the results of previous papers on the nonlinear interaction at wave propagation and scattering in the cold isotropic cylinder. The particular case of the nonlinear interaction of two electromagnetic fields occurring inside the infinitely long cylinder of the discharged plasma at the normal incidence of two plane waves with p-polarization is considered. (tr-auth)

54864 EXTRAORDINARY ELECTROMAGNETIC WAVE ABSORPTION IN THE LINEAR PLASMA LAYER IN THE HYBRID RESONANCE REGION. Omel'chenko, A. Ya.; Panchenko, V. I.; Stepanov, K. N. Izv. Vyssh. Ucheb. Zaved., Radiofiz.; 15: No. 5, 660-4(1972). (In Russian).

The results are given for numerical calculations of the field distribution and the absorption coefficient at the normal incidence of the extraordinary wave on the linear plasma layer regarding the effect of the field "swelling" in the hybrid resonance region. (tr-auth)

54865 REFLECTION OF ELECTROMAGNETIC WAVES AT THE OBLIQUE INCIDENCE ON THE MOVING FRONT OF IONIZATION. Semenova, V. I. Izv. Vyssh. Ucheb. Zaved., Radiofiz.; 15: No. 5, 665-74(1972). (In Russian).

The oblique incidence of monochromatic TE and TM waves on the sharp plasma boundary formed by the ionization source moving with a constant velocity is considered. Formulas on the reflection and transmission factors are obtained and investigated. The peculiarity of TE waves is the excitation in plasma outside the front of the longitudinal oscillations at any frequency of the incident transverse wave. (tr-auth)

54866 EQUATION OF STATE OF A NONIDEAL CESIUM PLASMA. Lomakin, B. N.; Fortov, V. E. (Moscow Physical-Technical Inst.). Zh. Eksp. Teor. Fiz.; 63: No. 1, 92-103(Jul 1972). (In Russian).

Experimental results are presented of a shock-wave investigation of the equation of state of a nonideal cesium plasma on a heated shock tube. The equation of state in the caloric form $H = H(P,V)$ can be determined by measuring the velocity of the shock discontinuity front and the plasma density; the equation is employed for plotting the isentropes and for calculation of the shock-compressed plasma temperatures. The results are compared with existing theories of plasma nonideality. The problem of phase transitions in a nonideal cesium plasma is discussed. (auth)

54867 KINETIC THEORY OF PARAMETRIC EXCITATION OF SURFACE WAVES IN SEMI-FINITE PLASMA. Aliev, Yu. M.; Gradov, O. M.; Kirii, A. Yu. (Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz.; 63: No. 1, 112-20(Jul 1972). (In Russian).

A theory of parametric excitation of quasi-static surface waves by a weak high-frequency electric field in a semi-finite plasma is developed. The case is considered when the external high-frequency field intensity vector is parallel to the plasma boundary, the field frequency is close to the proper frequency of the high-frequency quasi-static surface oscillations, and reflection of particles from the boundary of the plasma is specular. A dispersion equation is derived that describes plasma instability with respect to surface wave buildup. Threshold values of the external field strength above which such instabilities arise are found and the oscillation increments in the near-threshold region are calculated. (tr-auth)

54868 NONLINEAR EVOLUTION OF A QUASI-MONOCHROMATIC PACKET OF HELICAL WAVES IN A PLASMA. Istomin, Ya. N.; Karpman, V. I. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). Zh. Eksp. Teor. Fiz.; 63: No. 1, 131-42(Jul 1972). (In Russian).

Effects due to nonlinear interaction between resonant particles and quasi-monochromatic wave packets of circularly polarized waves propagating in a plasma along a magnetic field are considered. It is shown that the finiteness of the packet results in some new interesting phenomena that are not manifest in a constant-amplitude wave, viz. steepening of the packet fronts in a stable plasma and its compression, expansion of the packet in an unstable plasma, periodic amplitude modulation of a packet with a sufficiently steep leading front. The results are compared with experi-

ments on the propagation of monochromatic whistlers in a magnetosphere. (tr-auth)

54869 DAMPING OF LONG-WAVE PLASMA OSCILLATIONS. Kapitonov, V. S.; Popov, V. N. (Mathematics Inst., Moscow). Zh. Eksp. Teor. Fiz.; 63: No. 1, 143-9(Jul 1972). (In Russian).

Formulas that are exact in the long-wave limit, are derived for plasma oscillations damping due to collisions between charged particles. In a one-component plasma with a homogeneous compensating background the damping is $\sim k^2$ for $k \to 0$, whereas in a two-component plasma with particles of unequal masses it is constant for $k \to 0$. The integrals defining the damping are calculated explicitly for the one and two-component models in the limiting cases of a hot and cold Boltzmann plasma. (tr-auth)

PHYSICS (RADIATION AND SHIELDING)

54870 (NASA-TM-X-2440) PROCEEDINGS OF THE NATIONAL SYMPOSIUM ON NATURAL AND MANMADE RADIATION IN SPACE HELD AT LAS VEGAS, NEVADA, MARCH 1–5, 1971. Warman, E. A. (ed.) (Aerojet Nuclear Systems Co., Sacramento, Calif.). Jan 1972. 1020p. (CONF-710304). NTIS $10.00.

A separate abstract was prepared for each of 119 of 132 papers. Thirteen papers previously appeared in NSA; see NSA 25: 22777, 24154, 24155, 26178, 28784, 30630, 30631, 31640, 31671, 33390, 36250, 38173, and 57133. (L.M.T.)

For abstracts of individual papers see: 52985, 53093–53095, 53201–53203, 53230–53236, 53254–53256, 53289–53294, 53335–53338, 53345, 53399–53408, 53451–53458, 53529, 53695–53697, 53715, 53730, 53731, 53806, 53807, 53927–53931, 54001, 54002, 54044–54049, 54066, 54067, 54528, 54878–54889, 54945–54964, 55359–55373, and 55406.

Radiation Physics

Refer also to abstracts 53196, 53244, 53410, 53714, 54008, 54009, 54033, 54430, 54937–54939, 54963, and 55016.

54871 (CEA-CONF-1976) EVALUATION OF THE COMPONENTS OF THE ABSORBED DOSE IN THE INTERIOR OF ORGANISMS EXPOSED TO NEUTRONS. Dousset, M.; Ricourt, A.; Lemaire, G. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). [1971]. 24p. (In French). (CONF-711204–2). Dep. NTIS (U. S. Sales Only).

From Meeting on radiobiological applications of neutron irradiation; Vienna, Austria (6 Dec 1971).

The absorbed dose due to heavy charged particles and the absorbed dose due to secondary γ radiation were studied in cylinders whose dimensions were close to that of the rat, the rabbit, and the human for different energy spectrum of neutrons and for a large beam (large with respect to the animal irradiated). The base calculation for monoenergetic neutrons was applied to complex spectra. The results are shown graphically. The maximum of the dose due to secondary γ radiations in the rat varies in absolute value significantly with the spectrum. For the rabbit, the dimensions are sufficiently large so that the depth doses vary little in absolute value with the spectrum. For the human organism, the importance of the secondary radiations was confirmed. Experimental verification of the theoretical values obtained is in progress; the preliminary comparisons are encouraging. (J.S.R.)

54872 (CONF-720901–(Bks.1 and 2), pp 499-511) DOMINO: A GENERAL PURPOSE DISCRETE ORDINATES TO MONTE CARLO COUPLING CODE FOR RADIATION TRANSPORT. Burgart, C. E.; Emmett, M. B.; Hoffman, T. J. 1972.

From Meeting on new developments in reactor physics and shielding calculations; Kiamesha Lake, NY. (12 Sep 1972).

The ability to perform two-dimensional discrete ordinates calculations and couple the results with three-dimensional Monte Carlo calculations makes many calculations practical which would be quite difficult using the Monte Carlo method for the entire calculation. A method of coupling two-dimensional discrete ordinates calculations with Monte Carlo calculations of arbitrary geometric complexity is incorporated in the DOMINO code and associated routines. The coupling may take place on either a disk or cylindrical surface, thus the discrete ordinates calculation is limited to r–z geometry. The calculations may be coupled in either a forward mode, adjoint mode or as a forward-adjoint integration over the surface. The coupling may be performed either exactly or with approximations depending on the boundary conditions and configurations for both calculations. (auth)

54873 (EUR-4787) MICRODOSIMETRIC INVESTIGATIONS INTO THE ENERGY TRANSFER OF FAST NEUTRONS TO SOFT TISSUE. Oldenburg, U. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). 1972. 138p. (In German). Dep. NTIS (U. S. Sales Only).

Single-event spectra of fast neutrons were measured and calculated for spherical tissue-equivalent volumes of cellular and subcellular size (6.5 μm and 1.0 μm). The experimental spectra were measured with a 2″ Rossi counter. To provide the radiation fast neutrons were used of 0.62 MeV, 1.02 MeV, 2.01 MeV, 3.45 MeV, 4.44 MeV and 5.85 MeV, produced by a 3-MV Van De Graaff Generator and with thin targets. For the calculations a Monte Carlo program was written in Fortran IV, with which it was possible to simulate the experimental conditions on an IBM 360/65. The experimental and calculated spectra show good agreement above 5 keV/μm. For smaller event magnitudes, however, the corresponding experimental and theoretical spectra are entirely different. This difference must be attributed to the fact that the contamination of the neutron ray with gamma quanta and the neutron scatter in the collimator were not taken into account in the Monte Carlo calculation. The following investigations were also carried out using the Monte Carlo calculation: differences between energy absorption spectra and ionization spectra; proportion of charged secondary particles (p, d, t, α, C, N and O) in the single-event spectra; and breakdown of single-event spectra into crossers, insiders, stoppers, starters, and delta particles. (auth)

54874 (EUR-CEA-FC-647) HEATING OF VERY SMALL SOLID GRAINS BY ELECTRON AND ION BOMBARDMENT. Geller, R. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). May 1972. 23p. (In French). Dep. NTIS (U. S. Sales Only).

The bombardment of small agglomerates of matter with electrons and ions has various applications. An attempt was made to demonstrate qualitatively that the heating effect varies with the size of the agglomerate. It is assumed that the heating is due to collisions and absorption of secondary electrons and photons created in the matter by the incident particles. The mean free path, Λ, of the secondary particles is evaluated for the various collision processes by assuming that the solid target can be treated as a gas having a density of 4×10^{22} cm^{-3}. (The cross section data available for such gases are utilized.) The different Λ values are related to the different agglomerate diameters, ϕ. It is postulated that if $\Lambda > \phi$, the collision can not produce a heating effect. (France)

54875 (JINR-P1-6552) VAVILOV-CHERENKOV "NEEDLE" RADIATION IN ROCHELLE SALT CRYSTAL. Zrelov, V. P.; Pavlovich, P.; Shulek, P. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1972. 27p. (In Russian). Dep. NTIS (U. S. Sales Only).

By using 660-MeV protons and the photomethod the basic properties of the Vavilov–Cherenkov radiation were investigated in a biaxial crystal of Rochelle salt (RSC) having a polydomain structure. All the basic radiation properties predicted theoretically were confirmed. It was shown that the azimuthal radiation distribution with a definite polarization in the plate of the z-cut was of a peculiar "needle" character. (auth)

54876 (LA-4874, pp 145-52) DOSE COMPUTATIONS AND TREATMENT PLANNING IN PION THERAPY. Hendee, William R. (Colorado Univ., Denver. Medical Center). Mar 1972.

From fifth LAMPF users meeting; Los Alamos, NM. (8 Nov 1971).

The following subjects are discussed in a general manner: dose determination, tissue-equivalent materials for pions, reference dose, surface contour problem, the use of ultrasound, and use of computers for optimizing the treatment plan. (M.H.R.)

54877 (LA-4874, pp 153-61) RADIATION TREATMENT PLANNING USING PI MESONS. Lanzl, Lawrence H. (Argonne Cancer Research Hospital, Chicago, Ill. Chicago Univ., Ill. Dept. of Radiology). Mar 1972.

From fifth LAMPF users meeting; Los Alamos, NM. (8 Nov 1971).

The dosimetry systems for the conventionally used photons and electrons are reviewed briefly for guidance in the unexplored field of pion-treatment planning. It is suggested that a combination of the two photon dosimetry systems be considered for use in pion therapy. Methods for generating isodose distributions are discussed. The compensating filter is discussed. Principles have been worked out for accounting for inhomogeneities in two-dimensional isodose curves. The possible use of bolus material in combination with a wedge filter in treatment planning is suggested. (M.H.R.)

54878 (NASA-TM-X-2440, pp 104-7) GALACTIC COSMIC-RAY HEAVY PRIMARY SECONDARY DOSES. Wilkinson, M. C. (Boeing Co., Seattle); Curtis, S. B. Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

Results are presented of a calculation which estimates the heavy primary secondary doses from cosmic-ray-interaction data. The incident galactic cosmic-ray heavy primary spectrum is represented as the sum of helium, nitrogen (M group), magnesium (light heavy), and iron (very heavy) components. The incident iron nuclei are allowed to fragment into lesser Z secondaries, which are assumed to travel in the same direction and

start with the same energy per nucleon as the interacting primary. The total emergent particle energy spectra and dose are then presented for the galactic heavy primary spectrum incident on aluminum and tissue slabs. The importance of the fragmentation parameters assumed is also evaluated. The total dose from the heavy primaries and their secondaries is found to be reduced by only a factor of two in 20 g/cm^2 of shielding. (auth)

54879 (NASA-TM-X-2440, pp 157-61) FLUCTUATIONS IN ENERGY LOSS AND THEIR IMPLICATIONS FOR DOSIMETRY AND RADIOBIOLOGY. Baily, Norman A.; Steigerwalt, John E. (Univ. of California, San Diego, La Jolla). Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

A discussion is presented of the physics of energy deposition, with emphasis on their application to effects in biological systems. It is shown that energy deposition in small biological volumes has widely separated most-probable and average energy losses. Distribution functions are given for most probable and average energy losses of various charged particles in 1 micron of tissue. The validity of the concept of R.B.E. is questioned. It is concluded that a theory incorporating the probability for events of a given size in the volume of interest is needed for radiobiology and microdosimetry. (D.L.C.)

54880 (NASA-TM-X-2440, pp 364-7) MODULAR APPROACH FOR ASSESSING THE EFFECT OF RADIATION ENVIRONMENTS ON MAN IN OPERATIONAL SYSTEMS: RADIOBIOLOGICAL VULNERABILITY OF MAN DURING TASK PERFORMANCE. Ewing, Dean E. (Air Force Weapons Lab., Kirtland AFB, N. Mex.). Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

The feasibility of the model was proved and the practicality was assessed. It was applied to one operational system to date and the information obtained was submitted to systems analysts and mission planners for the assessment of man's vulnerability and impact on systems survivability. In addition, the model was developed so that the radiobiological data can be input to a sophisticated man–machine interface model to properly relate the radiobiological stress with other mission stresses including the effects of a degraded system. (auth)

54881 (NASA-TM-X-2440, pp 520-2) NEUTRONS PRODUCED BY KNOWN ENERGIES OF IONS ABUNDANT IN SPACE. Wadman, William W. (Univ of California, Irvine). Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

Ions of helium, boron, carbon, nitrogen, and oxygen were accelerated to 10.4 MeV/nucleon and directed onto copper or tantalum targets. The secondary neutron production was determined. From literature data on neutron production data for protons, deuterons, and alpha particles of various energies on various target materials, the neutron yield is a square function of the energy of the projectile ion. From the experimental data, neutron yields were extrapolated into the energy peak region of 300 MeV per nucleon for light ions in space. Beyond that energy, the ion energy spectrum falls off as $\sim E^{-2}$, producing a constancy in the neutron dose per ion beyond 300 MeV/nucleon. Such an extrapolation does not account for changes in the neutron spectra, modifications in the angular distribution in the higher energy model, or strange effects unique to very high energies per nucleon that are not now understood. (TSS)

54882 (NASA-TM-X-2440, pp 757-66) FREQUENCY OF LIGHT FLASHES INDUCED BY CHERENKOV RADIATION FROM HEAVY COSMIC-RAY NUCLEI. Madey, Richard; McNulty, P. J. (Clarkson Coll. of Tech., Potsdam, N. Y.). Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

Astronauts on Apollo missions 11 through 14 have reported seeing light flashes at a typical rate of about one per minute. The expected frequency of light flashes induced in the dark-adapted eye by Cherenkov radiation from cosmic heavy nuclei was calculated. In order to induce a visual sensation, at least two Cherenkov photons must be absorbed in coincidence by the rhodopsin molecules in a small area of the retina served by a single optic nerve fiber. The fact that the photons must be coincident on a small cluster of rods restricts the path length of the heavy nuclei for the production of relevant Cherenkov photons to a thin layer of the nervous tissue of the retina just ahead of the rods. The expected frequency of light flashes depends on the threshold number of photons that must be absorbed in a rod cluster. It is known that individual threshold values in the dark-adapted eye can vary by a factor of five even among young normal human subjects. The result of the calculation can be presented as a curve of the mean frequency of light flashes versus the threshold number of absorbed photons. The results are not sensitive to variations in the path length from 5 to 15 grams per square centimeter of water-equivalent before the nucleus reaches the retina. The calculations are based on the fluxes and energy spectra of galactic cosmic-ray nuclei helium to iron measured at a time of minimum solar modulation. The expected light-flash frequencies induced by Cherenkov radiation are consistent with the frequencies reported by the astronauts on Apollo missions 11 through 14. (auth)

54883 (NASA-TM-X-2440, pp 773-80) INFLUENCE OF A DETAILED MODEL OF MAN ON PROTON DEPTH/DOSE CALCULATIONS. Kase, Paul G. (Martin-Marietta Corp., Lakewood, Colo.). Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

The U. S. Air Force and NASA have jointly sponsored the development of a detailed radiation shielding model of man. This model will be used to plan manned space missions in which especially sensitive human tissues could be subjected to excessive radiation. The model has two configurations—standing and seated. More than 2500 individual elemental volumes are used to depict the external conformation, skeleton, and principal organs. The model is briefly described and several examples of its application to mission planning are given. (auth)

54884 (NASA-TM-X-2440, pp 786-91) MONTE CARLO PHOTOCURRENT/PHOTOMISSION COMPUTER PROGRAM. Chadsey, W. L.; Ragona, C. (General Electric Co., Philadelphia). Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

A Monte Carlo computer program (POEM) was developed for the computation of photocurrents and photoemission in gamma (x-ray)-irradiated materials. The program was used for application to the computation of radiation-induced surface currents on space vehicles and the computation of radiation-induced space-charge environments (IEMP) within space vehicles. The program was successfully correlated with published experimental data. (auth)

54885 (NASA-TM-X-2440, pp 792-800) PHOTON-INDUCED SECONDARY ELECTRON EMISSION. Spencer, R. B. (TRW Systems Group, Redondo Beach, Calif.); Smith, C. B.; McGrath, E. J. Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

Results of numerical models for predicting photon-induced secondary electron emission are presented for copper. These results are compared with recent experimental measurements made at UCLA using a ^{60}Co gamma-ray source. (auth)

54886 (NASA-TM-X-2440, pp 801-15) ELECTRON AND BREMSSTRAHLUNG PENETRATION AND DOSE CALCULATION. Watts, John W. Jr.; Burrell, Martin O. (Marshall Space Flight Center, Huntsville, Ala.). Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

Various techniques for the calculation of electron and bremsstrahlung dose deposition are described. New energy deposition, transmission, and reflection coefficients for electrons incident on plane slabs for angles of 0, 30, 60, 75, and 89.9° and energies of 0.5, 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, and 10.0 MeV are presented, and methods for their use in electron dose calculations are developed. A method for electron dose calculations using the "straight-ahead" approximation is also developed, and the various methods are compared and found to be in good agreement. Accurate and approximate methods of calculating bremsstrahlung dose are derived and compared. The approximation is found to give good order of magnitude estimate of dose where the electron spectrum falls off exponentially with energy. The primary weakness of both calculations is the approximation of the bremsstrahlung source angular distribution; the actual distribution is not easily determined. 24 figures. (auth)

54887 (NASA-TM-X-2440, pp 821-31) APPLICATION OF THE PHASE-SPACE-TIME EVOLUTION METHOD TO ELECTRON SHIELDING. Cordaro, Matthew C. (Long Island Lighting Co., Hicksville, N. Y.); Zucker, Martin S. Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

A computer technique for treating the motion of charged and neutral particles and called the phase-space-time-evolution (PSTE) method was developed. This technique employs the computer bookkeeping capacity to keep track of the time development of a phase space distribution of particles. This

method was applied to a study of the penetration of electrons. A 1-MeV beam of electrons normally incident on a semi-infinite slab of aluminum was used. Results of the calculation were compared with Monte Carlo calculations and experimental results. Time-dependent PSTE electron penetration results for the same problem are presented. 13 figures. (auth) (STAR)

54888 (NASA-TM-X-2440, pp 894-901) RADIATION MEASUREMENTS AND DOSES AT SST ALTITUDES. Foelsche, Trutz (Langley Research Center, Hampton, Va.). Jan 1972.
From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

A brief survey of experimental and theoretical results of biologically important radiation components and dose equivalents due to galactic and solar cosmic rays in the high atmosphere, especially at SST altitudes, is presented. The dose equivalent rate for the flight personnel flying 500 hours per year in cruise altitudes of 60,000–65,000 feet (18–19.5 km) in high magnetic latitudes turned out to be about 0.75 to 1.0 rem per year averaged over the solar cycle, or about 15 to 20 percent of the maximum permissible dose rate for radiation workers as established by ICRP for peacetime operations (5 rem per year). The gross of passengers, who do not encounter major solar events, would be exposed only to the low level galactic cosmic rays. Such exposure would amount to some mrem per North-Atlantic trip and is therefore negligible. Very rarely, groups of passengers, who happen to be passing through the impact zone of a rare giant solar event such as that of February 23, 1956, would be exposed to 0.45 rem, provided the airplane descends to subsonic altitudes at the beginning of the event and continues its flight at the lower altitudes. This exposure, 0.45 rem, is 90 percent of the permissible limit for individuals of the general population (0.5 rem per single year). At cruise altitude, the maximum permissible limit would have been surpassed. The suggested evasion measure of descending to lower altitudes is therefore sufficient to avoid overexposure of passengers in such rare cases. 22 references. (auth)

54889 (NASA-TM-X-2440, pp 902-7) DOSE AND LINEAR ENERGY TRANSFER SPECTRAL MEASUREMENTS FOR THE SUPERSONIC TRANSPORT PROGRAM. Philbrick, Richard B. (Air Force Weapons Lab., Kirtland AFB, N. Mex.). Jan 1972.
From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

Radiation monitoring systems are being flown on board aircraft provided by the Air Weather Service. The purpose of the package, called the High Altitude Radiation Instrumentation System (HARIS), is to measure the radiation hazard to Supersonic Transport passengers from solar and galactic cosmic rays. The HARIS includes a gaseous linear-energy-transfer spectrometer, a tissue-equivalent ionization chamber, and a Geiger–Mueller tube. The HARIS is flown on RB-57F aircraft at 60,000 feet from Eielson Air Force Base, Alaska. During solar-active periods, crews of the 58th Weather Reconnaissance Squadron are on alert to launch the aircraft during solar flares. Data from the HARIS are reduced to give rad and rem dose rates measured by the package during the flights. Results presented include ambient data obtained on background flights, altitude comparison data, and solar flare data. (auth)

54890 (ORNL-TM-3816) RADIATION TRANSPORT CODES FOR POTENTIAL APPLICATIONS RELATED TO RADIOBIOLOGY AND RADIOTHERAPY USING PROTONS, NEUTRONS, AND NEGATIVELY CHARGED PIONS. Armstrong, T. W. (Oak Ridge National Lab., Tenn.). Aug 1972. 27p. Dep. NTIS.

In connection with long-term programs in space-vehicle, accelerator, and reactor shielding, the Oak Ridge National Laboratory has developed rather sophisticated calculational methods for determining the transport in matter of protons, neutrons, pions, muons, electrons, and photons. This work has resulted in several Monte Carlo radiation-transport computer codes which are quite general with respect to allowable source-particle descriptions, geometries, material compositions, etc. Recently, a limited study has been directed toward applying some of these computer codes to predict quantities of interest in the fields of radiotherapy and radiobiology, such as depth-dose patterns, and toward assessing the accuracy of the codes for applications in these fields. Here, the calculational methods are described and comparisons of calculated and experimental results are presented for dose distributions produced by protons, neutrons, and negatively charged pions. Comparisons of calculated and experimental cell-survival probabilities are also presented. (auth)

54891 (SLAC-153) CONCEPTS OF RADIATION DOSIMETRY. Kase, Kenneth R.; Nelson, Walter R. (Stanford Linear Accelerator Center, Calif.). Jun 1972. Contract AT(04-3)-515. 214p. Dep. NTIS.

The basic information required to understand the principles of photon and charged-particle dose measurement is discussed, from basic particle interactions to cavity chamber theory. The extension of dosimetry principles to the high-energy situation is emphasized. The following topics are covered: the interaction of electromagnetic radiation with matter, charged-particle interactions, energy distribution in matter, dose calculations, and measurement of radiation dose–cavity-chamber theory. (53 references) (M.H.R.)

54892 EXPERIMENTALLY MEASURED DOSE ALBEDOS OF INTERMEDIATE ENERGY BREMSSTRAHLUNG. Crites, Thomas R. (Sandia Corp., Albuquerque, N. Mex.). Nucl. Sci. Eng.; 49: No. 1, 103-6(Sep 1972).

The backscatter of normally incident bremsstrahlung spectra photons from semi-infinite materials was investigated experimentally. The bremsstrahlung sources were broad-beam radiation from a 2.0-MeV radiographic Van de Graaff and high-intensity flash x-ray devices of 3.5-, 7.0-, and 10.5-MeV peak energy. The scattering media were concrete, iron, and lead. Four backscattering angles (120, 130, 140, and 150°) were studied. The scattered radiation was measured by means of thermoluminescent dosimeters (LiF) located in collimated shields. The experiments were designed for shielding studies, and the results are presented in a form primarily for use in health protection shielding calculations. (2 figures, 1 table) (auth)

54893 FAST-NEUTRON THERAPY TREATMENT PLANNING. McGinley, Patton Hopkins. Atlanta; Georgia Inst. of Tech. (1971). 153p. University Microfilms Order No. 72-5053.
Thesis.

A clinical trial is being conducted at Hammersmith Hospital, London, using fast neutrons with an average energy of 7.65 MeV and future trials, in which 14 MeV-neutrons will be employed, are being considered. Dose distributions for use in neutron radiotherapy were experimentally determined. Tissue-equivalent ionization chambers were utilized in conjunction with thermoluminescent dosimeters to establish the neutron and γ-ray doses deposited in tissue irradiated by beams of 14-MeV neutrons. Dose distributions in homogeneous and heterogeneous phantoms containing lung and bone components were determined at a source-to-skin distance of 125 cm. From these measurements it was concluded that the dose distributions due to 14-MeV neutrons have properties that make them suitable for use in radiotherapy. However, improved collimation and shielding systems will be required in order to reduce the whole-body dose received by a patient undergoing neutron therapy. An examination of the dose distributions revealed that the percent depth dose at points within the volume of tissue irradiated could be predicted by means of an empirical equation. Based on these measurements, only a slight change in the soft-tissue dose distribution was produced by bone. On the other hand, an increased dose was found for points in and behind the lungs as compared to the dose that would be obtained in a homogeneous phantom. A discussion of the sources of error in the experimental measurements is included as well as suggestions for future work related to 14-MeV neutron therapy. (Diss. Abstr. Int., B)

54894 ENERGY SPECTRUM OF ELECTRONS IN WATER IRRADIATED WITH 10- TO 20- MeV ELECTRON BEAMS. Weiss, Herbert; Epp. Edward R.; Heslin, Jane (Sloan-Kettering Inst. for Cancer Research, New York). Radiat. Res.; 51: No. 2, 211-28(Aug 1972).

The spectrum of the fluence of slowed-down electrons in a water medium irradiated by an external beam of electrons from a betatron was measured. The measurements were made at a number of depths in the medium and for a number of incident electron energies. The approach used was to set an evacuated probe at the point of interest for a number of angular increments. Electrons traveling down the probe within an angle of $\theta \pm 0.6°$ were then detected by a plastic scintillator. The measured spectra were corrected for coincidences and resolution distortion by means of a response function matrix. The fluence spectra were converted to distributions in LET. (auth)

54895 MICRODOSIMETRY OF 250 kVp AND 65 kVp X RAYS, ^{60}Co GAMMA RAYS, AND TRITIUM BETA PARTICLES. Ellett, W. H.; Braby, L. A. (Twinbrook Research Lab., Rockville, Md. Battelle-Northwest Lab., Richland, Wash.). Radiat. Res.; 51: No. 2, 229-43(Aug 1972).

Energy deposition from single events occurring in spherical sites ranging in diameter from about 50 to 550 $\mu g\ cm^{-2}$ was studied by means of a grid-walled proportional counter. Single- and multiple-event spectra from medium- and low-energy bremsstrahlung are compared to those produced by ^{60}Co gamma rays and tritium beta rays. From these spectra the dose-mean specific energy from single events and the number of events per rad exceeding a given event size are calculated for sites of various diameter. The relevancy of these data to the Kellerer–Rossi theory of dual

radiation action is discussed and, for each of the radiations studied, an estimate is made of the dose range in which the biological effects vary linearly or as the square of the dose. (auth)

54896 DOSE ACROSS A PLANE BONE–TISSUE INTERFACE. Kulkarni, R. N.; Sundararaman, V.; Prasad, M. A. (Directorate of Radiation Protection, Trombay, India). Radiat. Res.; 51: No. 1, 1-9(Jul 1972).

The contribution of photoelectrons to the dose across a plane bone/tissue interface due to x irradiation is calculated using the moments method for the following three angular distributions of photoelectrons: the distribution calculated according to the nonrelativistic Heitler formula; forward; and isotropic. The dose depends to a large extent upon the type of angular distribution assumed. Further, the earlier approximation that the electrons travel in straight lines is also found to introduce a certain amount of error. On the basis of the investigations the total dose across a plane bone/tissue interface has been arrived at by using the Heitler distribution of photoelectrons and by adding to this dose the contribution of Compton electrons which is nearly the same in bone and tissue. (auth)

54897 DISTRIBUTION OF DEEP DOSES NEAR IMPLANTED BETA AND MIXED BETA–GAMMA EMITTERS. Dubinin, I.; Huvar, A. (UJEP, Brno). Cesk. Radiol.; 25: No. 6, 249-51(Nov 1971). (In Czech).

The mathematical method for the assessment of the distribution of deep doses near implanted beta and mixed beta and gamma emitters is described, and the possibility of calculating linear absorption coefficients for both types of radiation is discussed. (auth)

54898 MONTE CARLO INVESTIGATIONS OF CATASTROPHIC COLLISIONS WITH CHARACTERISTICS OF SCATTERED ELECTRON RADIATION TAKEN INTO ACCOUNT. Baranov, V. F.; Arutyunov, V. V.; Zrazhun, A. G.; Smirnov, V. V. This paper was summarized in At. Energ. (USSR); 31: No. 1, 51-2(Jul 1971) as paper No. 506/6062. (In Russian).

Full copy of this paper is held by TIC.

An algorithm for Monte Carlo calculations of the energy and angular distributions of electron radiation scattered on a barrier and on a semi-infinite medium as it impinges on the surface of absorber, with the radiation arriving in the form of a broad beam of monoenergetic electrons, is presented. The calculations take catastrophic collisions of electrons leading to the formation of secondary delta electrons into account, as well as the contribution of the delta electrons to the energy distributions and angular distribution of the scattered electron radiation. The energy of the primary electrons ranged from 0.2 to 5 MeV. Aluminum and a tissue-equivalent medium were used as the absorber. The results of the calculations were compared with available experimental data on the transmission coefficients of the electrons and the angular distributions of the scattered electron radiation. The comparison revealed that the calculated characteristics of the scattered electron radiation are in closer agreement with the experimental results, over a wide range of energies, than calculations based on the continuous slowing-down model are. (TSS)

54899 NOTE ON THE LARGE-DEPTH DECREASE OF RANGE AND DAMAGE PROFILES. Winterbon, K. B. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Radiat. Eff.; 15: No. 1-2, 73-5(Jul 1972).

The large-depth decrease of heavy-ion path-length, projected range, and deposited-energy distributions is calculated, assuming power-cross-section nuclear stopping, and estimated in the general case. The rate of decrease can be exponential at sufficiently low incident ion energies and becomes gaussian at high energies. (auth)

54900 COMPUTERIZED DOSIMETRY OF ^{60}Co OPHTHALMIC APPLICATORS. Chan, Bun; Rotman, Marvin; Randall, Gerald J. (New York Medical Coll. Memorial Hospital, New York). Radiology; 103: No. 3, 705-7(Jun 1972).

Theoretical dose distributions of ^{60}Co ophthalmic applicators were calculated with the aid of a computer and the results were compared with experimental measurements obtained by thermoluminescent dosimetry and film emulsions in phantoms. The Sievert line-source method was partially corrected for oblique filtration; however, a more precise dose description should include a program which completely corrects for oblique absorption in the ophthalmic applicator. (auth)

54901 CORRECTION OF ISODOSE-DIAGRAMS FOR ^{60}Co AND 35 MeV ELECTRONS AT PENETRATION OF LUNG TISSUE. Nordberg, U.-B. (Univ. of Lund, Sweden). Acta Radiol., Ther., Phys., Biol.; 11: No. 2, 113-28(Apr 1972).

A simple method for the construction of individual isodose curves in lung tissue for ^{60}Co and 35-MeV electrons is described. The validity of the method was experimentally verified. A mean volume weight for normal lung tissue was determined for 13 patients. (auth)

54902 LOCAL DOSE FROM NEUTRON-PRODUCED-RECOIL IONS IN THE REGION OF A THERAPEUTIC ^{252}Cf NEEDLE. Jones, T. D.; Auxier, J. A. (Oak Ridge National Lab., Tenn.). Radiology; 104: No. 1, 187-9(Jul 1972).

An attempt is made to provide data accurate enough to permit treatment of neoplasms which may show a significant change in radiosensitivity due to a 10% variation in radiation dose. A Monte Carlo neutron transport code was used to compute distributions of dose from neutron-produced-recoil ions about a 20-mm ^{252}Cf needle implanted in soft-tissue media. The results were normalized to free space kerma, and these normalized results were averaged in order to obtain values for a mean tissue medium. Coefficients of variation ranged from 1 to 3.5% for this mean tissue. (auth)

54903 PERTURBATION OF ISODOSE DISTRIBUTIONS ADJACENT TO CAVITIES IN TISSUE-EQUIVALENT MEDIA DURING IRRADIATION BY 10 TO 35 MeV ELECTRONS. Starchman, Dale E.; Chao, Jen-hung (IIT Research Inst., Chicago, Mercy Hosptial, Chicago). Radiology; 104: No. 1, 177-86 (Jul 1972).

Quantitative determination of the effect of cavities on the dose measured by an ionization chamber at a suitable point behind the cavity has shown that the percentage of dose increase varies markedly as a function of the build-up layer, the diameter and thickness of the cavity, and the electron energy. A study of dose distribution showed that cylindrical cavities similar in size to those encountered in the head and neck may result in a localized dose of up to 160% of that measured at the depth of maximum dose within a homogeneous tissue-equivalent medium. (auth)

54904 BROAD-BEAM ATTENUATION IN LEAD FOR X RAYS FROM 50 TO 300 kVp. Kelley, John P.; Trout, E. Dale (Oregon State Univ., Corvallis). Radiology; 104: No. 1, 171-5(Jul 1972).

Broad-beam attenuation data were obtained under conditions updated to present filtrations using uniform geometry and measuring techniques. The results were in remarkably good agreement with those in NCRP reports, when it is considered that the NCRP data were taken from several papers published over a period of about thirty years. (auth)

54905 SCATTERED RADIATION FROM A TISSUE-EQUIVALENT PHANTOM FOR X RAYS FROM 50 TO 300 kVp. Trout, E. Dale; Kelley, John P. (Oregon State Univ., Corvallis). Radiology; 104: No. 1, 161-9(Jul 1972).

Data were taken showing the ratio of scatter-to-incident exposure over a kilovoltage range of 50 to 150 kVp for radiographic conditions wherein the field was centered on the scatterer and wherein the field is at the edge of the scatterer, using a phantom that has a shape similar to that of the trunk of the human body. Similar data were taken for conditions used in therapy for the voltage range of 50 to 300 kVp. The data presented here will be useful to those setting up recommended methods for calculating secondary protective barriers. (auth)

54906 DOSE TABLES FOR ^{252}Cf IMPLANTS. Bloch, Peter; Krishnaswamy, V.; Hale, John (Univ. of Pennsylvania, Philadelphia). Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 115: No. 4, 822-33(Aug 1972

The neutron and gamma dose rate was calculated for ^{252}Cf planar and multiplanar cuboid implants for the Paterson–Parker source distribution system and for the Quimby source distribution system. A modified distribution system for planar implants is described that produces a dose uniformity of ±10 per cent in the target area. This system uses the uniform source distribution of the classical Quimby system with the following modifications: the length of the implant is longer than the length of the treatment area; and the sources at the edge of the implant are left in place longer than the inner sources of the implant. (auth)

54907 EFFECT OF THE MEDIUM ON RADIATION EMISSION BY RELATIVISTIC ELECTRONS. Arutyunyan, F. R.; Nazaryan, A. A.; Frangyan, A. A. (Inst. of Physical Research, Erevan). Zh. Eksp. Teor. Fiz.; 62: No. 6, 2044-8(Jun 1972). (In Russian).

The experimental data on radiation emission by 0.25- to 3.7-GeV electrons in periodic lamellar media and single layers are compared with various theories. It is shown that the experimental data are in good agreement with the theory of resonance emission if account is made for the effect of multiple electron scattering in the lamellar medium. (auth)

54908 THEORETICAL CALCULATION OF SPACE DISTRIBUTION OF DOSE FIELD OF ^{60}Co γ IRRADIATION UNDER A LATTICE. Barkova, A. M.; Kholin, V. V. (Leningrad Inst. for the Advancement of Medicine). Med. Radiol.; 16: No. 11, 64-70 (Nov 1971). (In Russian).

Calculations were made of the depth of dose of ^{60}Co γ radiation under covered and uncovered sections of a protective lattice. Limits were evaluated, beginning with the point where shadow effects become important. A projection method was developed for the quantitative estimation of shadow effects at different depths in tissue. A table is presented which shows the percentage of deep dose under lattices of various types. (tr-auth)

54909 CALCULATION OF INTEGRAL ABSORBED DOSE IN ELECTRON THERAPY OF TUMORS. Khvan, G. V. (Kazakh Scientific-Research Inst. for Oncology and Radiology, USSR). Med. Radiol.; 16: No. 11, 70-3(Nov 1971). (In Russian).

Proceeding from measurements and analysis of known isodose patterns for betatrons with a formed electron flux of 10 to 35 MeV energy, a simple method of calculation of an integral absorbed dose is suggested. In the formula a quadratic relationship for description of the distribution of the specific ionization by depth is used. For transition from the specific ionization to the absorbed dose, the known transition coefficients for primary electrons and mean coefficients for secondary electrons are used. (auth)

54910 INTEGRAL ABSORBED DOSES: EXAMPLES. Bercy, A. (Univ., Liege). J. Belge Radiol.; 54: No. 4, 516-22(1971). (In French).

By means of diagrams and a simple formula, the integral doses absorbed in the known means of radiography (X rays and γ rays) are calculated. The possibility of calculating the integral dosage absorbed during interstitial radium therapy is also demonstrated. A few examples are given in proof of the utility of calculating the integral dose absorbed, also in radioprotection. (auth)

54911 DISTRIBUTION OF QUALITATIVE COMPOSITION AND ABSORBED DOSES OF X-IRRADIATION IN USING THE SCREENS. Nguyen Van Thien; Zaboronskii, A. A.; Krongauz, A. N.; Titov, A. A. (Moscow Scientific-Research Rentgeno-Radiological Inst.). Med. Radiol.; 16: No. 11, 56-9(Nov 1971). (In Russian).

To study the distribution of the effective energies and of absorbed doses of x irradiation acting in the irradiated medium under screen filters, two miniature semiconductor detectors were used. Experimental data of the values of effective energies and of distribution of absorbed doses at various depths of a tissue-equivalent phantom were obtained. (auth)

54912 DOSIMETRY OF ^{87m}Sr. Beck, Robert N. (Argonne Cancer Research Hospital, Chicago). J. Nucl. Med.; 13: No. 9, 705(Sep 1972).

The radiation dose from ^{87m}Sr was calculated using the formulas from Johns and Cunningham (The Physics of Radiology, 1969, pp 570-573). The bone dose was found to be 14.8 mrad/100 μ Ci. The calculation of Meckelnburg (J. Nucl. Med., 5: 929-35(1964)) which uses a similar formula was found to be in error by a factor of 10. (M.H.R.)

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Refer also to abstracts 53247, 53248, and 53331.

54913 RADIATION PROTECTION GUIDES AND CONSTRAINTS FOR SPACE-MISSION AND VEHICLE-DESIGN STUDIES INVOLVING NUCLEAR SYSTEMS. Report of the Radiobiological Advisory Panel of the Committee on Space Medicine, Space Science Board, National Academy of Sciences-National Research Council. Washington, D. C.; National Academy of Sciences (1970). 81p. $0.25. Space Science Board, Washington, D. C.

The results are presented of an attempt to formulate tentative radiation protection guides to be used as criteria in mission-planning and vehicle-design studies for manned space operations contemplated during the next 10 to 20 years. The bases for deliberations are contained in four appendices: A, in which radiation design criteria are suggested; B, which describes the reusable nuclear rocket program, the proposed missions for reusable systems, and suggested radiation design criteria; C, which includes a publication on a 25-kWe reactor-thermoelectric power system for manned orbiting space stations; and D, NASA document MSC-00183 entitled "Radiation Environment for the 1975-1985 Space Station Program," which predicts radiation exposure rates as a function of uniform cylinder wall thickness (g/cm^2 of aluminum) for a 270-nautical-mile, 55°-inclined orbit, 200-nautical-mile polar orbit, and an equatorial earth-synchronous orbit. (M.H.R.)

54914 RADIATION PROTECTION STANDARDS: QUO VADIS. VOLUME I. Proceedings of the Sixth Annual Health Physics Society Topical Symposium, Richland, Washington, November 2-5, 1971. Howell, Wallace P.; Corley, John P. (comps.). Richland, Wash.; Health Physics Society (1972). 263p. (CONF-711119-(Vol.1)).

A separate abstract was prepared for each of 11 of a total of 13 papers. Two of the remaining papers appeared previously in NSA; see NSA 26: 9556 and 12512. (M.O.W.)

For abstracts of individual papers see: 53134, 53435, 53523, 53536, and 54915-54921.

54915 ROLE OF THE NCRP IN THE DEVELOPMENT OF RADIATION PROTECTION STANDARDS. Taylor, Lauriston S. (National Council on Radiation Protection and Measurements, Washington, D. C.). pp 16-32 of Radiation Protection Standards: Quo Vadis. Vol. I. Howell, Wallace P. (ed.). Richland, Wash.; Health Physics Society (1972).

From 6th annual topical symposium on radiation protection standards: quo vadis; Richland, Wash. (2 Nov 1971).

The National Council on Radiation Protection and Measurements has, for over 40 years, played a key role in the development of radiation protection standards in the U.S. and, in fact, internationally. It dedicated itself to the safer use of radiation for many years before the subject became a popular and political problem. At the same time it feels that proper and productive uses of radiation must not be needlessly curtailed even if some slight risk is involved—virtually nothing is without some element of risk. The NCRP does not regard itself as a "standards setting" body in the strict sense; it develops "recommendations" on protection standards and practices, expecting these to be utilized or modified to meet special needs. Input to its recommendations are primarily scientific or technical, but other considerations enter as needed. Council membership and operating procedures are designed to maximize the diversity of knowledge and organizational affiliations and minimize the possibility of any group, small or large, dominating its policies and recommendations. Council recommendations represent its best judgment based on information up to the sign-off date of a report; it does not necessarily wait for that new data that is just around the corner. It does not attempt to fully document its statements nor does it present its reports as treatises. Its recommendations are those of the Council members, to every one of whom every report is submitted for approval before release. It is anticipated that the NCRP will broaden its radiation protection activities during the foreseeable future. (auth)

54916 AMERICAN NATIONAL STANDARDS INSTITUTE AND NUCLEAR STANDARDS. Fleckenstein, D. C. (General Electric Co., Schenectady, N. Y.). pp 33-49 of Radiation Protection Standards: Quo Vadis. Vol. I. Howell, Wallace P. (ed.). Richland, Wash.; Health Physics Society (1972).

From 6th annual topical symposium on radiation protection standards: quo vadis; Richland, Wash. (2 Nov 1971).

The history and organization of the American National Standards Institute (ANSI) is summarized. Procedures for the development of American National Standards are described. Nuclear standards activities in general, and radiation protection standards programs in particular, are used as examples of ANSI operations and will provide the current status of these efforts. ANSI affiliation with the International Organization for Standardization (ISO) is reported. ISO technical committees of interest are described. Some ANSI future plans and programs in the nuclear standards area are given. (auth)

54917 DESCRIPTION OF THE AMERICAN NUCLEAR SOCIETY'S INFORMATION CENTER ON NUCLEAR STANDARDS (ICONS) RADIATION PROTECTION STANDARDS: QUO VADIS. Voigt, Keith L.; DuTemple, Octave J.; Brown, Roberta S. (American Nuclear Society, Hinsdale, Ill.). pp 50-9 of Radiation Protection Standards: Quo Vadis. Vol. I. Howell, Wallace P. (ed.). Richland, Wash.; Health Physics Society (1972).

From 6th annual topical symposium on radiation protection standards: quo vadis; Richland, Wash. (2 Nov 1971).

The American Nuclear Society recently organized an Information Center on Nuclear Standards (ICON). The reasons for its establishment, its purpose, goals and services are described in detail. Considerable background information concerning the concept of Information Analysis Centers (IAC), their organization and usefulness is discussed. A step-by-step description of the mechanics for setting up an IAC is given. Sources of data, input, storage, retrieval, analysis of data and output of ICONS' information are identified. The purpose and role of the Technical Advisor is explained along with the relationship of ICONS to other standards writing organizations. A new IAC dimension was added with the establishment of ICONS. In addition to providing the traditional services of an IAC, ICONS will periodically take on assignments

of a special nature. For example, a thorough examination of the possibility of organizing a nuclear industry-sponsored standards and codes enforcing agency similar to the air- and marine-industry will be made. ICONS, through its Technical Advisors, will take on the task of evaluating, analyzing, and describing why a nuclear industry-sponsored standards and codes enforcing agency is needed, if indeed it is needed; suggest how such an organization could be organized and supported; who could direct this agency; what its purpose and functions should be; and, other considerations important to the development of a preliminary working model. A discussion of the marketing plan for ICONS is included. (auth)

54918 ROLE OF THE HEALTH PHYSICS SOCIETY IN THE DEVELOPMENT OF RADIATION PROTECTION STANDARDS. Vallario, E. J. (Health Physics Society Standards Committee, Washington, D. C.). pp 60-9 of Radiation Protection Standards: Quo Vadis. Vol. I. Howell, Wallace P. (ed.). Richland, Wash.; Health Physics Society (1972).

From 6th annual topical symposium on radiation protection standards: quo vadis; Richland, Wash. (2 Nov 1971).

The Health Physics Society Standards Committee (HPSSC) is a permanent committee of nine Society members assigned to represent the Society to the Board of Directors on matters concerned with standardization of practices in radiation protection. Its multiphased role is to advise the officers and members of the Society on new developments in the field of standardization, examine the need for new standards, establish expert working groups under the HPSSC to develop priority standards and maintain liaison with other standard making organizations to accomplish these objectives effectively. An ancillary function is to provide the Board of Directors technical assistance to establish a Society position on major issues involving new radiation protection standards. (auth)

54919 RECENT ACTIVITES IN THE DEVELOPMENT OF SURFACE CONTAMINATION STANDARDS. Gallagher III, F. E.; Evraets, J. C.; Tschaeche, A. N.; Willis, C. A. (Health Physics Society, Richland, Wash.). pp 206-15 of Radiation Protection Standards: Quo Vadis. Vol. I. Howell, Wallace P. (ed.). Richland, Wash.; Health Physics Society (1972).

From 6th annual topical symposium on radiation protection standards: quo vadis; Richland, Wash. (2 Nov 1971).

The Standards Committee of the Southern California Chapter, Health Physics Society, has prepared a "Position Paper on Surface Contamination Standards for Radioactive Materials." It was written to discuss the need for these standards and to establish the basic criteria for their development, because of the widespread disagreement among health physicists concerning many of the important details. The paper was reviewed by the Health Physics Society Standards Committee in November, 1970, and a revised version, dated January 15, 1971, has been accepted. As a result of this activity, the Health Physics Society Standards Committee has recently established a subcommittee to write surface contamination standards, using the position paper's criteria as background material. A summary of the paper's final version is presented here. (auth)

54920 SUMMARY OF RADIOACTIVE SURFACE CONTAMINATION GUIDES. Schmidt, Gail D. (Bureau of Radiological Health, Rockville, Md.). pp 216-27 of Radiation Protection Standards: Quo Vadis. Vol. I. Howell, Wallace P. (ed.). Richland, Wash.; Health Physics Society (1972).

From 6th annual topical symposium on radiation protection standards: quo vadis; Richland, Wash. (2 Nov 1971).

Results of investigations of guides used for the control of radioactive surface contamination are presented. The study includes: (1) a summary of the guides used by over 40 nuclear facilities in 1965 or recommended in the literature, (2) the guides adopted by U. S. Regulatory agencies, (3) the contamination level associated with MPC (air) based upon resuspension factors, and (4) contamination levels from operational experiences that have been associated with internal body burdens. The investigations indicate that most U.S. nuclear facilities use a conservatively low contamination guide that has apparently been most effective in limiting internal exposure. The data from resuspension studies and operational experience tends to support the values recommended by Dunster (Health Physics, 8: 353-6, (1962). Recently adopted or suggested contamination studies continue to exhibit considerable diversity of opinion. Suggested radioactive contamination guides that represent a compromise are presented along with the admonition that, as a territory standard, they be applied with professional judgment. (3 tables, 19 references) (auth)

54921 SAFETY CRITERIA FOR NUCLEAR POWER IN SPACE. Willis, C. A. (McDonnell Douglas Astronautics Co., Huntington Beach, Calif.). pp 236-56 of Radiation Protection Standards: Quo Vadis. Vol. I. Howell, Wallace P. (ed.). Richland, Wash.; Health Physics Society (1972).

From 6th annual topical symposium on radiation protection standards: quo vadis; Richland, Wash. (2 Nov 1971).

The appropriateness of nuclear power for space application has long been recognized. There have been numerous applications, including Apollo, but the full potential has not been realized. The uncertainty about safety requirements is one of the limiting factors. There are no established criteria for the acceptable risk associated with space nuclear power. It follows that there is no concrete basis for assuring program management that a system will be acceptably safe, no matter how good it may be. Conversely, there is no firm justification for safety requirements because the resulting system may or may not be approved with or without the precautionary measure. A study of the safety criteria problem is reported which compares the various standards which have been met and the criteria which have been suggested. It is concluded that general criteria can be developed and should be the object of concentrated effort. (3 figures, 68 references). (auth)

54922 RADIATION PROTECTION STANDARDS: QUO VADIS. VOLUME II. Proceedings of the Sixth Annual Health Physics Society Topical Symposium, Richland, Washington, November 2–5, 1971. Howell, Wallace P.; Corley, John P. (comps.). Richland, Wash.; Health Physics Society (1972). 244p. (CONF-711119–(Vol.2)).

A separate abstract was prepared for each of 17 of the total of 20 articles. Three articles appeared previously in NSA; see NSA 26: 8575, 9541, and 11453. (M.O.W.)

For abstracts of individual papers see: 53246–53248, 53436, 53510, and 54923–54934.

54923 APPLICATION OF RADIATION EXPOSURE STANDARDS IN THE AEC CONTRACTOR PROGRAM. Ross, Donald M. (Atomic Energy Commission, Washington, D. C.). pp 309-15 of Radiation Protection Standards: Quo Vadis. Vol. II. Howell, Wallace P. (ed.). Richland, Wash.; Health Physics Society (1972).

From 6th annual topical symposium on radiation protection standards: quo vadis; Richland, Wash. (2 Nov 1971).

The AEC radiation protection guides applicable to contractor operations are embodied in AEC Manual Chapter 0524. The basic guides have been derived from the recommendations of the Federal Radiation Council (FRC) whose functional responsibilities have recently been incorporated into those of the newly established Environmental Protection Agency (EPA). In those areas that remained uncovered by the FRC, the AEC follows the recommendations of the National Council on Radiation Protection and Measurements (NCRP) and the International Commission on Radiological Protection (ICRP). (auth)

54924 AEC REGULATORY PROGRAM. Gamertsfelder, Carl C. (Atomic Energy Commission, Washington, D. C.). pp 316-21 of Radiation Protection Standards: Quo Vadis. Vol. II. Howell, Wallace P. (ed.). Richland, Wash.; Health Physics Society (1972).

From 6th annual topical symposium on radiation protection standards: quo vadis; Richland, Wash. (2 Nov 1971).

The Commission's regulation entitled "Standards for Protection Against Radiation," (10 CFR Part 20) establishes standards for external radiation exposure and permissible concentrations in air and water which are based on the recommendations of the NCRP, ICRP, and the FRC. There are also implementing provisions and procedures to assure that every reasonable effort is made to maintain radiation exposures as far below the specified limits as practicable. Other parts of the regulations provide the framework for dealing with byproduct, source and special nuclear materials, and certain nuclear facilities. In these parts, the basic standards are applied in more detail through the requirement for specific licenses which are issued after thorough review of the facilities and the procedures to be used. Control over other activities, of a more routine nature or of more limited scope, are provided by general licenses. In some certain cases, usually related to a specific product or class of products, for which it can be shown that individuals are not likely to be exposed to more than a few percent of the dose limits, the use of the products may be exempted from regulatory control. The Commission recently revised its regulations for the licensing of nuclear power reactors to include requirements for keeping radioactive effluents as low as practicable and is in the process of defining numerical guidance on what can be considered to be as low as practicable. (auth)

54925 APPLICATIONS OF RADIATION PROTECTION RECOMMENDATIONS IN THE DEVELOPMENT OF FEDERAL RADIATION STANDARDS FOR ELECTRONIC PRODUCTS. Snow, Donald L.; Little, Marshall S.; Snavely, David R. (Bureau of Radiological Health, Rockville, Md.). pp 322-43 of Radiation Protection Standards: Quo Vadis. Vol. II. Howell, Wallace P. (ed.). Richland, Wash.; Health Physics Society (1972).

From 6th annual topical symposium on radiation protection standards: quo vadis; Richland, Wash. (2 Nov 1971).

Experiences are reviewed in applying radiation protection recommendations of voluntary standards-setting organizations in the development of regulations to control radiation emissions from electronic products. The impact of voluntary standards on regulatory standards is discussed from such standpoints as: (1) enforceability aspects of standards, (2) needs for documenting the development of the regulatory standards, and (3) conversion of radiation exposure criteria to radiation emission criteria for specific electronic products. The responsibility of a regulatory agency to establish safety factors for emission criteria, based on reasonableness and technical feasibility considerations, is discussed. Also considered are those difficulties which develop when (1) no prior consideration has been given by voluntary standards groups to a problem area, or (2) there is no available information on the technical or scientific bases for recommendations from national or international groups. Factors which may cause a regulatory agency to deviate in whole or part from an accepted national or international recommendation are reviewed to develop further understanding as to where improvements may be possible at every level of the standards development process. (auth)

54926 OCCUPATIONAL SAFETY AND HEALTH ACT OF 1970. Beeston, Richard (Occupational Safety and Health Administration, Seattle). pp 344-51 of Radiation Protection Standards: Quo Vadis. Vol. II. Howell, Wallace P. (ed.). Richland, Wash.; Health Physics Society (1972).

From 6th annual topical symposium on radiation protection standards: quo vadis; Richland, Wash. (2 Nov 1971).

The Williams–Steiger Act is without question the most far-reaching piece of legislation in this field ever enacted. It has reached a new level in thinking about occupational safety and health. The purpose, coverage, responsibility of employees and employers are highlighted. In addition, the enforcement aspects of this Act are discussed along with the Occupational Safety and Health Standards and the particular application of the Radiation Protection Standards in the field of occupational health. (auth)

54927 EPA ROLE IN RADIATION PROTECTION. Palmiter, C. C. (Environmental Protection Agency, Rockville, Md.). pp 352-6 of Radiation Protection Standards: Quo Vadis. Vol. II. Howell, Wallace P. (ed.). Richland, Wash.; Health Physics Society (1972).

From 6th annual topical symposium on radiation protection standards: quo vadis; Richland, Wash. (2 Nov 1971).

The President's Reorganization Plan No. 3 transferred to the Environmental Protection Agency, all the functions of the former Federal Radiation Council to provide Guidance to Federal agencies and from the Atomic Energy Commission the responsibility for setting generally applicable environmental standards. As a result of this transfer, the EPA is now responsible for completing the general review of the guidance issued by the FRC in 1960. It recently issued guidance which limits the exposure of underground uranium miners to the short-lived progeny of radon-222 to 4 WLM per year. It also solicited comments from other Federal agencies regarding the adoption by the Federal Government of all or part of the new recommendations made in NCRP Report No. 39. (auth)

54928 STANDARDS AND STATE REGULATORY CONTROL PROGRAMS. Moen, Arnold J. (Washington State Div. of Health, Olympia). pp 357-61 of Radiation Protection Standards: Quo Vadis. Vol. II. Howell, Wallace P. (ed.). Richland, Wash.; Health Physics Society (1972).

From 6th annual topical symposium on radiation protection standards: quo vadis; Richland, Wash. (2 Nov 1971).

The evolution of regulatory control programs from standards through custom, tradition, and fear is discussed. Problems of establishing regulations to meet the standards and to control major sources of exposure not covered by standards are explored. Establishment of uniformity among states' regulations to avoid unnecessary limitation of interstate activities complicate regulations. These complications make regulations difficult to understand or interpret when locally applied. Enforcement of state regulations is hampered by lack of inherent pressures of custom or tradition. Familiarity through use of radiation, development of bad habits, and lack of knowledge or concern are discussed as deterrents to compliance. Practical problems of establishing motivation to comply through enforcement of regulations are discussed. Lack of involvement of users and states in the standard setting procedures creates problems in establishing regulations and in enforcement of compliance. (auth)

54929 WHY BENEFIT-RISK ANALYSIS? Cohen, Jerry J. (Univ. of California, Livermore). pp 362-5 of Radiation Protection Standards: Quo Vadis. Vol. II. Howell, Wallace P. (ed.). Richland, Wash.; Health Physics Society (1972).

From sixth annual topical symposium on radiation protection standards: quo vadis; Richland, Wash. (2 Nov 1971).

A brief discussion is given on the risk of radiation as compared to the benefit of radiation. Low doses are discussed in particular. (M.O.W.)

54930 WHOSE BENEFIT? WHOSE RISK? WHOSE BALANCE? Grendon, Alexander (Univ. of California, Berkeley). pp 377-85 of Radiation Protection Standards: Quo Vadis. Vol. II. Howell, Wallace P. (ed.). Richland, Wash.; Health Physics Society (1972).

From sixth annual topical symposium on radiation protection standards: quo vadis; Richland, Wash. (2 Nov 1971).

Benefits and risks are generally viewed too narrowly in discussions of radiation standards. This paper tries to expand the perspective, showing some benefits and risks in applications of nuclear energy and radiation that are often overlooked and identifying the population segments affected by them. Because of the wide range of these benefits and risks and of the subpopulations involved, it becomes virtually impossible to compare overall benefits and risks in setting limits of total population exposure; only in particular cases, or for limited classes, is such an effort potentially useful. In those cases, social and political factors need to be weighed along with the technical considerations; for the technical complexity requires delegation of responsibility for that task by the public to specially qualified judges rather than direct voting by an uninformed electorate—a system that is a logical extension of our form of representative democracy. (auth)

54931 BENEFIT–RISK RATIOS: SOME ECCENTRIC VIEWS. Sagan, Leonard A. (Palo Alto Clinic, Calif.). pp 386-400 of Radiation Protection Standards: Quo Vadis. Vol. II. Howell, Wallace P. (ed.). Richland, Wash.; Health Physics Society (1972).

From 6th annual topical symposium on radiation protection standards: quo vadis; Richland, Wash. (2 Nov 1971).

The strategy that ICRP has adopted for control of public exposure to radiation is to assume that effects of radiation may occur, even at very low doses. Therefore, any industrially produced radiation exposure, such as from nuclear power plants, should be justified in terms of a cost-benefit calculation. Unfortunately, they do not provide guidelines for such calculations. Nor in traditional economics is there a theoretical background for estimating and charging costs for human effects produced by releases to the environment. The author proposes that an emissions tax for pollutants, including radioactivity, be established, and that this tax be based on a linear extrapolation from high dose effects and on a standard dollar value of man. Market mechanisms then would operate to control and allocate emissions among industrial users in a more efficient and equitable manner than could be achieved through arbitrary regulatory mechanisms. (auth)

54932 RISKS OF BENEFIT–RISK ANALYSIS. Connolly, T. J. (Stanford Univ., Calif.). pp 401-9 of Radiation Protection Standards: Quo Vadis. Vol. II. Howell, Wallace P. (ed.). Richland, Wash.; Health Physics Society (1972).

From 6th annual topical symposium on radiation protection standards: quo vadis; Richland, Wash. (2 Nov 1971).

The various efforts to date to develop a benefit–risk methodology share a common vision of a goal the achievement of which will enable persons to weigh an evaluation of benefits against an evaluation of all forms of costs of a given innovation and decide whether the balance favors proceeding with the innovation or not. Risks comprise that portion of costs which are borne by individuals in the form of discomfort, ill health, injury or death. The authors confess to some skepticism regarding the extent to which benefit–risk analysis can usefully be developed. It is the theme of this paper that any valid methodology that may be developed should satisfy certain criteria that can be defined at this time. These criteria are discussed. Some assumptions common to benefit–risk analysis are questioned in the light of various social–psychological studies. (auth)

54933 INDUSTRY'S UNDERSTANDING OF THE RADIATION CONTROVERSY. Olds, Fredric C. (Power Engineering Magazine, Barrington, Ill.). pp 444-51 of Radiation Protection Standards: Quo Vadis. Vol. II. Howell, Wallace P. (ed.). Richland, Wash.; Health Physics Society (1972).

From 6th annual topical symposium on radiation protection standards: quo vadis; Richland, Wash. (2 Nov 1971).

Critics of nuclear power in the United States have had great success in spite of minimum financial resources. One finds in Europe that now they are turning sentiment against nuclear power there—often with arguments and people imported from the U. S. How can the critics have this success on a shoestring if they have been discredited as the industry claims? Some important answers were found by looking at the principles of communication which the nuclear industry uses well in a market-competitive situation, but

which it uses poorly in an adversary situation where it has to debate a fervent, sometimes fanatical opposition. Errors in communications tactics were illustrated by examples. Basic principles of adversary communications, as they apply to the nuclear power situation, were discussed. Commonly, the industry's strategy in the struggle for the public repute it wants has been superficial. (auth)

54934 USE AND ABUSE OF STANDARDS. Tschaeche, A. N. (General Electric Co., San Jose, Calif.). pp 458-64 of Radiation Protection Standards: Quo Vadis. Vol. II. Howell, Wallace P. (ed.). Richland, Wash.; Health Physics Society (1972).

From 6th annual topical symposium on radiation protection standards: quo vadis; Richland, Wash. (2 Nov 1971).

The growing need for formulating standards is discussed with respect to freeing the plant and laboratory health physicist for more creative and productive work on unique problems. Various types of documents, e.g., material specifications, testing methods, standard terminology, and safety rules are used to illustrate the important differences between standards as rules and standards as guides or models. The abuse of standards, e.g., improper application and blind incorporation in regulations, is illustrated. A method of applying standards to the solution of particular radiation measurement and protection problems is proposed toward stimulating the production of effective standards. (auth)

54935 EXPOSURE RATE. Buchan, R. C. T. (Plymouth General Hospital, Eng.). Brit. J. Radiol.: 45: No. 536, 628 (Aug 1972).

Concern is expressed that in connection with specifications for x-ray tube output, the term exposure rate is defined as the quotient of exposure by electrical charge. It is pointed out that the ICRU defines exposure rate as the quotient of Δx by Δt, where Δx is the increment in exposure in time Δt. This is expressed in units such as mR/sec, mR/min, mR/hr, rather than R/mA/min or mR/mA/sec. (UK)

Radiation Source Calibration and Standardization

54936 DETERMINATION OF THICKNESS OF γ-SOURCES AND ABSORBERS FROM THE DEFORMATION OF THE HARD PART OF THE ENERGY SPECTRUM. Vorob'ev, V. A.; Fridman, Sh. D. This paper was summarized in At. Energ. (USSR); 30: No. 4, 385(Apr 1971) as paper No. 480/5877. (In Russian).

Full copy of this paper is held by TIC.

A method is described for determining the thickness of remote γ sources and absorbers by taking account of the deformation of the hard part of the energy spectrum of the γ radiation from distributed sources. This deformation is measured by a quantity ξ defined as the ratio of the intensity of the primary γ radiation J_0 of energy E_0 to the differential intensity of the hard scattered γ radiation J_0 as $E \to E_0$, i.e., $\xi = J_0^{\Sigma}/J_0^{\Sigma}$. Relations are presented that associate the function ξ with the thickness of an inactive absorber, and in the absence of an absorber, with the thickness of the radiation source for a plane isotropic source, a uniform half-space, and a uniform layer. Graphs of $\xi(\mu x, \vartheta)$ were computed for a vertical collimated detector with a half-angle aperture $\theta \to 0^0$, and also for ϑ equal to 30, 60, and 90° for a range of thicknesses $0.1 \leq \mu x \leq 5.0$. The method is very sensitive. (auth)

Shielding Calculations and Theory

Refer also to abstracts 53138, 53930, 54892, 54913, 55140–55144, 55360, 55364, 55365, 55368, 55371–55373, 55382, 55383, and 55424.

54937 (CONF-720901–(Bks.1 and 2), pp 349-84) INTEGRAL EXPERIMENTS AND PHILOSOPHY OF BENCHMARK CALCULATIONS. Straker, E. A. 1972.

From Meeting on new developments in reactor physics and shielding calculations; Kiamesha Lake, NY. (12 Sep 1972).

After surveying the benchmark problem and needs, the author points out the apparent renewed interest in standards, benchmarks, etc. Much of the need arises because, at present, radiation transport calculations for complex shielding problems use very large computer codes requiring large data bases, with inherent problems in accuracy of results. From 1967 to present, there was only one addition to the Shielding Benchmark Problem book; during this period there have been numerous measurements and calculations that can be considered candidates. After presenting in one table the characteristics of benchmarks two other tables are used to summarize, respectively, integral experiments and reference calculations that might be considered as benchmarks. The author concludes that, because of the scope of the job, efforts at maintaining "benchmark books" will undoubtedly fall short of the goal. He feels, however, that perhaps it is not too important whether the results are labeled "benchmark" or not; it is probably sufficient to make readily available information about a large number of different types of problems that have received careful consideration. (94 references) (L.M.T.)

54938 (CONF-720901–(Bks.1 and 2), pp 385-96) DEVELOPMENTS IN INTEGRAL SHIELDING EXPERIMENTS INVOLVING FAST-NEUTRON TRANSPORT. Harris, L. Jr. (Gulf Radiation Tech., San Diego, Calif.). 1972.

From Meeting on new developments in reactor physics and shielding calculations; Kiamesha Lake, NY. (12 Sep 1972).

The evolution of integral shielding experiments involving fast-neutron transport is reviewed briefly and recent developments in third generation experiments are described. (M.H.R.)

54939 (CONF-720901–(Bks.1 and 2), pp 397-408) CARBON SHIELDING BENCHMARK PROBLEM AND OTHER NEUTRON TRANSPORT CALCULATIONS IN CARBON. Goldstein, H.; Soran, P. D.; Weisbin, C. R. (Columbia Univ., New York). 1972.

From Meeting on new developments in reactor physics and shielding calculations; Kiamesha Lake, NY. (12 Sep 1972).

Moments method and S_N calculations are presented for the scalar neutron fluxes in Shielding Benchmark Problem 1.0—an isotropic, fission-like source in a carbon medium. It is found that deep penetration of neutrons in carbon is governed by cross section phenomena that do not affect the penetration at such small distances as are involved in the Benchmark problem. It is, therefore, not yet clear how well existing transport methods can calculate deep penetrations in carbon. Flux-ages-to-indium-resonance energy are calculated for a fission source and a number of monoenergetic sources. Differences between the values given here and those presented elsewhere are correlated with differences in the microscopic cross-section sets used. (auth)

54940 (CONF-720901–(Bks.1 and 2), pp 512-23) SENSITIVITY ANALYSIS: A GENERAL APPROACH ILLUSTRATED FOR A Na–Fe SYSTEM. Bartine, D. E.; Oblow, E.; Mynatt, F. R. (Oak Ridge National Lab., Tenn.). 1972.

From Meeting on new developments in reactor physics and shielding calculations; Kiamesha Lake, NY. (12 Sep 1972).

A general approach to sensitivity studies is introduced using a quantitative definition of cross-section sensitivity. The definition offered is intended to be both practical and physically meaningful. Its advantages in comparison with other approaches is discussed and its use in analysis is illustrated for a sodium–iron transport problem. Results of the analysis include a discussion of the role of important total cross-section minima in deep penetration in sodium and iron and the importance of certain energy ranges and partial cross sections for the sodium-iron system. The predictive aspect of the approach is demonstrated in comparisons of rigorous and predicted results for small cross-section perturbations and in conclusions about the order of Legendre expansion of the scattering kernel. (auth)

54941 (CONF-720901–(Bks.1 and 2), pp 541-58) SHIELDING APPLICATION OF PERTURBATION THEORY TO DETERMINE CHANGES IN NEUTRON AND GAMMA DOSES DUE TO CHANGES IN SHIELD LAYERS. Fieno, Daniel (Lewis Research Center, Cleveland). 1972.

From Meeting on new developments in reactor physics and shielding calculations; Kiamesha Lake, NY. (12 Sep 1972).

Perturbation theory for fixed sources was applied to radiation shielding problems to determine changes in neutron and gamma-ray doses due to changes in various shield layers. For a given source and detector position the perturbation method enables dose derivatives due to all layer changes to be determined from one forward and one inhomogeneous adjoint calculation. The direct approach requires two forward calculations for the derivative due to a single layer change. Hence, the perturbation method for obtaining dose derivatives permits an appreciable savings in computation for a multilayered shield. For an illustrative problem, a comparison was made of the fractional change in the dose per unit change in the thickness of each shield layer as calculated by perturbation theory and by successive direct calculations; excellent agreement was obtained between the two methods. (auth)

54942 (CONF-720901–(Bks.1 and 2), pp 574-6) EFFECTIVE MULTIPLE-CONSTRAINT SHIELD OPTIMIZATION TECHNIQUE. Billings, M. P. (McDonnell Douglas Astronautics Co., West Huntington Beach, Calif.). 1972.

From Meeting on new developments in reactor physics and shielding calculations; Kiamesha Lake, NY. (12 Sep 1972).

A general technique developed at McDonnell Douglas Astro-

nautics Company and applied to a variety of shield optimization problems has proven extremely effective in essentially all important aspects; realistically representing system variables (no restriction in geometric modeling is required), simply accommodating any number of (inequality) constraints, accurately representing the dependence of radiation levels and shield mass on the variables, providing computational efficiency, and achieving the optimal result for a given problem. (auth)

54943 (CONF-720901-6) SENSITIVITY ANALYSIS: A GENERAL APPROACH ILLUSTRATED FOR A Na–Fe SYSTEM. Bartine, D. E.; Oblow, E.; Mynatt, F. R. (Oak Ridge National Lab., Tenn.). 1972. 14p. Dep. NTIS.

From Meeting on new developments in reactor physics and shielding calculations; Kiamesha Lake, NY. (12 Sep 1972).

A general approach to sensitivity studies is introduced using a quantitative definition of cross-section sensitivity. The definition offered is intended to be both practical and physically meaningful. Its advantages in comparison with other approaches are discussed, and its use in analysis is illustrated for a sodium/iron transport problem. Results of the analysis include a discussion of the role of important total cross-section minima in deep penetration in sodium and iron and the importance of certain energy ranges and partial cross sections for the sodium/iron system. The predictive aspect of the approach is demonstrated in comparisons of rigorous and predicted results for small cross-section perturbations and in conclusions about the order of Legendre expansion of the scattering kernel. (auth)

54944 (NAA-SR-Memo-8597) ANALYSIS OF THE STF NEUTRON TRANSMISSION MEASUREMENTS (INITIAL MEASUREMENTS). Engle, W. W. (Atomics International, Canoga Park, Calif.). 5 Jun 1963. Contract AT(11-1)-Gen-8. 9p. Dep. NTIS.

The data from the experimental neutron flux measurements in LiH performed at the Shield Test Facility was used as input data for SMAC II. The results of several sets of experimental data are presented. (auth)

54945 (NASA-TM-X-2440, pp 40-7) IMPACT OF RADIATION DOSE ON NUCLEAR SHUTTLE CONFIGURATION. Goetz, C. A.; Billings, M. P. (McDonnell Douglas Astronautics Co., West Huntington Beach, Calif.). Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

The impact of nuclear radiation (from the NERVA propulsion system) on the selection of a reference configuration for each of two classes of the Reusable Nuclear Shuttle (RNS) is assessed. One class was characterized by a single propellant tank, the shape of whose bottom was found to have a pronounced effect on crew radiation levels and associated shield weight requirements. A trade study of shield weight versus structural weight indicated that the minimum-weight configuration for this class had a tank bottom in the shape of a frustum of a 10°-half-angle cone. A hybrid version of this configuration was found to affect crew radiation levels in substantially the same manner. The other class of RNS consisted of a propulsion module and eight propellant modules. Radiation analyses of various module arrangements led to a design configuration with no external shield requirements. (auth)

54946 (NASA-TM-X-2440, pp 48-56) EFFECTS OF RADIATION ENVIRONMENT ON REUSABLE NUCLEAR SHUTTLE SYSTEM. Lane, A. G. (North American Rockwell, Downey, Calif.). Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

Since radiation protection for a manned nuclear rocket represents the most significant design constraint, major emphasis has been placed upon parametric tradeoff analyses of a wide spectrum of alternate tank configurations to minimize both primary and secondary, direct and scattered radiation sources emanating from the NERVA (nuclear engine for rocket vehicle application). The analytical approach utilizing point kernel techniques is described and detailed data are presented on the magnitude of neutron/gamma doses for different locations. Dose rates are presented for both engine firing and post-shutdown periods. Conical aft bulkhead geometries employing a range of included half cone angles from 5 to 15 degrees and end cap radii from 25 to 125 inches were evaluated. Single-tank configurations utilizing smaller cone angles and end cap radii were found to minimize integral radiation levels, hence, stage shielding-weight penalties for shuttle missions. This is due to the greater payload separation distance, reduction of the effective energy disposition and scattering centers in the aft end of the tank, and greater depth of the liquid hydrogen propellant for radiation attenuation at any given time during the draining cycle for a fixed tank propellant capacity. Hybrid configurations employing an upper tank with a reduced cone angle and end cap radius results in low integral payload doses primarily due to the increased separation distance caused by the elongation of the larger capacity upper tank. A preliminary radiation damage assessment is discussed of possible reusable nuclear shuttle (RNS) materials, components, and subsystems, and the possible effects of the radiation environment on various phases of RNS mission operations, i.e., maintenance, rendezvous, docking, and engine disposal. (auth)

54947 (NASA-TM-X-2440, pp 58-64) RADIATION ANALYSIS OF VARIOUS VEHICLE AND PAYLOAD CONFIGURATIONS FOR THE REUSABLE NUCLEAR SHUTTLE. Preeg, W. E. (Aerojet Nuclear Systems Co., Sacramento). Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

Radiation analyses were performed and shielding weight requirements were estimated for various candidate vehicle and payload configurations for use with the Reusable Nuclear Shuttle. The analyses included both Point Kernel and Monte Carlo approaches. The effects on reduced shield weight were determined for propellant tanks with pointed conical tank bottoms and for one case of a cluster of small (15 ft diameter) tanks. This latter case, however, had an arrangement which had no center tank in the upper tier of tanks. This effect negated most of the gain of going to the smaller tanks. A range of shield weights is presented for various light and heavy manned payload configurations when used in conjunction with a single liquid hydrogen propellant tank, 33 ft in diameter with a 15° conical tank bottom. (auth)

54948 (NASA-TM-X-2440, pp 78-83) PRELIMINARY SHIELD DESIGN FOR A SNAP-8 POWER SYSTEM. Karp, I. M.; Soffer, L.; Clark, M. R. (Lewis Research Center, Cleveland, Ohio). Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

A preliminary shield design for a nuclear power system utilizing a SNAP-8 reactor for space base application is presented. A representative space base configuration was selected to set the geometry constraints imposed on the design. The base utilizes two independent power packages each with a reactor operating at 600 kwt and each producing about 50 kwe. The crew compartment is located about 200 feet from each reactor and is large enough in extent to intercept a total shadow angle of 60° measured about the center line of each reactor. Reactor dose constraints for the shield design were: (1) the dose to the crew over a 6 month mission was set at 150 mrem/day, (2) the dose along the side of either power system was set at 30 mrem/hr at a distance of 200 feet, based on considerations of exposure during repair to one power system while the other is operating, and (3) the dose constraint elsewhere around the reactor was set at 5 rem/hr at a distance of 200 feet. Personnel are not expected to be in this region during operation of the power systems except possibly for very brief periods during approach and departure from the base. The shield design presented incorporates the results of calculations and some preliminary engineering considerations. The weight of the idealized layered lithium hydride and depleted uranium shield layout used as the calculational model was about 35,000 pounds whereas the preliminary engineering layout of the shield which includes structure, canning materials, clearance gaps between layers, etc. weighed about 41,000 pounds. (auth)

54949 (NASA-TM-X-2440, pp 92-7) SPACE-REACTOR SHIELDING FABRICATION. Welch, Frank H. (Atomics International, Canoga Park, Calif.). Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

A new facility has been constructed at the Atomics International Nuclear Field Laboratory for the fabrication of space reactor neutron shielding by a melting and casting process utilizing lithium hydride. This facility is equipped to handle lithium hydride not only under the exacting conditions dictated by the nature of the reactive, moisture sensitive material, but also under the stringent requirements of the nuclear shielding engineer for high purity, maximum density, good structural integrity, etc. This facility is capable of producing lithium hydride neutron shields up to 8 feet in diameter weighing 10,000 lbs. In addition, the facility contains a 1650 cubic feet nitrogen atmosphere, glove-ported room capable of handling these massive shields during a destructive examination to determine the internal characteristics of the shield after thermal and vibrational tests simulating operation conditions. The first neutron shield fabricated in this new facility was a large, pancake shape 86 inches in diameter, containing about 1700 pounds of lithium hydride. This shield, fabricated by the unique melting and casting process, is the largest lithium hydride shield ever built. (auth)

54950 (NASA-TM-X-2440, pp 98-102) NUCLEAR REACTOR DESCRIPTIONS FOR SPACE POWER SYSTEMS ANALYSIS. McCauley, E. W.; Brown, N. J. (Univ. of California, Livermore). Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

For the small, high-performance reactors required for space electric applications, adequate neutronic analysis is of crucial importance, but in terms of computational time consumed, nuclear calculations probably yield the least amount of detail for mission analysis study. It has been found possible, after generation of only a few designs of a reactor family in elaborate thermomechanical and nuclear detail to use simple curve-fitting techniques to assure desired neutronic performance while still performing the thermomechanical analysis in explicit detail. The resulting speedup in computation time by three orders of magnitude permits a broad detailed examination of constraints by the mission analyst. (auth)

54951 (NASA-TM-X-2440, pp 108-16) METHODS OF SPACE RADIATION-DOSE ANALYSIS WITH APPLICATIONS TO MANNED SPACE SYSTEMS. Langley, R. W.; Billings, M. P. (McDonnell Douglas Astronautics Co., Huntington Beach, Calif.). Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

The full potential of state-of-the-art space radiation dose analysis for manned missions has not been exploited. Point doses have been overemphasized, and the critical dose to the bone marrow has been only crudely approximated, despite the existence of detailed man models and computer codes for dose integration in complex geometries. The method presented makes it practical to account for the geometrical detail of the astronaut (which typically provides as much protection to the internal organs as does the vehicle) as well as the vehicle. This paper discusses the major assumptions involved and presents the concept of applying the results of detailed proton dose analysis to the real-time interpretation of on-board dosimetric measurements. (auth)

54952 (NASA-TM-X-2440, pp 170-7) GEOMAGNETICALLY TRAPPED RADIATION ENVIRONMENT: A RADIOLOGICAL POINT OF VIEW. Holly, F. Eugene (Air Force Weapons Lab., Kirtland AFB, N. Mex.). Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

The regions of naturally occurring, geomagnetically trapped radiation (Van Allen Belts) are briefly reviewed in terms of physical parameters such as particle types, fluxes, spectra, and spatial distributions. The major emphasis is, however, placed upon a description of this environment in terms of the radiobiologically relevant parameters of absorbed dose and dose rate and a discussion of the radiological implications in terms of the possible impact on space vehicle design and mission planning. These descriptions are based both upon direct measurement and calculation using the more fundamental parameters of particulate energy and flux. Comparison of such calculations with measurements emphasizes that, depending upon the location in space, that calculational techniques are extremely dependent upon detailed knowledge of either the energy spectrum or material (shielding) distribution about the dose point, or both. 35 references. (auth)

54953 (NASA-TM-X-2440, pp 215-19) APOLLO MISSION EXPERIENCE. Schaefer, Herman J. (Naval Aerospace Medical Research Lab., Pensacola, Fla.). Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

Dosimetric implications for manned space flight are evaluated by analyzing the radiation field behind the heavy shielding of a manned space vehicle on a near-earth orbital mission and how it compares with actual exposure levels recorded on Apollo missions. Emphasis shifts from flux densities and energy spectra to incident radiation and absorbed doses and dose equivalents as they are recorded within the ship at locations close to crew members. (auth) (STAR)

54954 (NASA-TM-X-2440, pp 251-6) INFLUENCE OF RADIATION SHELDING ON REUSABLE NUCLEAR SHUTTLE DESIGN. Littman, T. M.; Garcia, D. (North American Rockwell, Downey, Calif.). Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

The nuclear rocket's unique energy source affords unusually high performance while requiring special protection for manned flights. If maximum capability is to be achieved without compromising development or operating costs, stage designs must employ efficient methods for minimizing radiation shield requirement. With this objective, alternate Reusable Nuclear Shuttle (RNS) configurations were synthesized and evaluated. Particular attention was given to design factors which reduced tank exposure to direct and scattered radiation, increased payload-engine separation, and improved self-shielding by the LH_2 propellant. The most attractive RNS concept in terms of cost effectiveness (unit payload delivery cost) consists of a single conical aft bulkhead tank with a high fineness ratio (eight-degree half cone-angle with a 25-inch cap radius). Launch is accomplished by the INT-21 with the tank positioned in the inverted attitude. The NERVA engine is delivered to orbit separately where final stage assembly and checkout are accomplished. This approach is consistent with NERVA definition criteria and required operating procedures to support an economically viable nuclear shuttle transportation program in the post-1980 period. (auth)

54955 (NASA-TM-X-2440, pp 310-23) RISK OF SOLAR PROTON EVENTS TO SPACE MISSIONS. Burrell, Martin O. (Marshall Space Flight Center, Huntsville, Ala.). Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

The total dose in rads-tissue from solar protons was tabulated for weekly time intervals, and the number of weeks which gave a dose above 25 rads behind 10 g/cm^2 of aluminum for the active 6 years of the 19th cycle were called dangerous or large-event weeks. The number of such event weeks was found to be only 3 weeks for the past 20 years. Even though the chance for smaller events is examined, it was found that for any reasonable high confidence level (95%), the smaller events could be ignored. Consequently, the total particle flux for the 19th cycle was divided by a factor of 3 and determined a single large event week. Using this spectrum, the tissue dose in rads is calculated at the center of an aluminum spherical shell. To correct for geometric effects and self shielding, this dose may be reduced by a factor of about 3. To predict the probability of an event occurring, the Poisson distribution was the most logical choice. The confidence one can use in employing the Poisson process and arriving at confidence levels for the experimental value of the mean is investigated. Several examples are given for different mission lengths, and comparisons are made to other authors' results. An extension of the Poisson process is made to incorporate the concept of small-sample theory and arrive at the expected distribution function which answers the following question: if x_0 events are observed in time t_0, what is the probability of seeing x events in any observation time t? (10 tables, 9 figures) (auth)

54956 (NASA-TM-X-2440, pp 324-8) PROBABLE SOLAR-FLARE DOSES ENCOUNTERED ON AN INTERPLANETARY MISSION AS CALCULATED BY THE MCFLARE CODE. Lahti, Gerald P.; Karp, Irving M. (Lewis Research Center, Cleveland). Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

The computer program, MCFLARE, uses Monte Carlo methods to simulate solar flare occurrences during an interplanetary space voyage. The total biological dose inside a shielded crew compartment due to the flares encountered during the voyage is determined. The computer program evaluates the doses obtained on a large number of trips having identical trajectories. From these results, a dose D_p having a probability p of not being exceeded during the voyage can be determined as a function of p for any shield material configuration. The user of the code selects any number of solar flares considered to be representative of the ones that will occur during future solar active periods (these flares are generally selected from the flares that occurred during the last solar active period 1956 to 1962). The flares are assumed to occur during these periods. The dose at a distance of 1 AU from the Sun from each of these flares behind any shield configuration investigated is input to the MCFLARE code. The code accounts for the dependence of the dose received from a flare on the distance from the Sun according to a $(1/r)^{\alpha}$ variation, where r is the distance from the Sun and the exponent α can be assigned. From trajectory parameters, which are input to the computer program, the distance from the Sun as a function of time during the trip is calculated. To illustrate the use of the code, a trip to Mars and return is calculated, and estimated doses behind several thicknesses of aluminum shield and water shield are presented. (auth)

54957 (NASA-TM-X-2440, pp 368-74) OPTIMAL SHIELD MASS DISTRIBUTION FOR SPACE RADIATION PROTECTION. Billings, M. P. (McDonnell Douglas Astronautics Co., Huntington Beach, Calif.). Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

Computational methods were developed and successfully used for determining the optimum distribution of space radiation shielding on geometrically complex space vehicles. These methods have been incorporated in the computer program SWORD which uses the full capability of state-of-the-art methods for dose evaluation in

complex geometry, and iteratively calculates the optimum distribution of (minimum) shield mass satisfying multiple acute and protracted dose constraints associated with each of several body organs. The technique used to accommodate multiple constraints eliminates the awkward discontinuities associated with the formulation of inequality constraints and produces a result meeting mathematical tests for optimality. (auth)

54958 (NASA-TM-X-2440, pp 375-82) DEVELOPMENT AND VERIFICATION OF DESIGN METHODS FOR DUCTS IN A SPACE NUCLEAR SHIELD. Cerbone, R. J.; Selph, W. E.; Read, P. A. (Gulf Radiation Tech., San Diego, Calif.). Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

A practical method for computing the effectiveness of a space nuclear shield perforated by small tubing and cavities was developed and tested. Analysis of ducts and voids in a shield cannot be performed using the two-dimensional transport methods that are presently the most efficient means of analyzing reactor and shield problems. A three-dimensional Monte Carlo analysis is too costly to consider in tradeoff studies. The approach to the problem is to use solutions of a two-dimensional transport code and to evaluate perturbations of that solution using last-flight estimates and other kernel integration techniques. In general, perturbations are viewed as a change in the source strength of scattered radiation and a change in attenuation properties of the region, and the effect of these changes is evaluated by performing last-flight estimates and point kernel integrations. This method was implemented in a new computer program called DUCT. Calculations performed with the DUCT code were compared to experiments conducted at the Gulf Radiation Technology Linac facility. The shield studies involved measurements on a lithium hydride assembly with a sodium-filled duct and a NERVA-BATH shield mockup. Comparison was also made with the MORSE Monte Carlo code. Overall agreement between measurements, DUCT, and MORSE is better than 10 percent. (auth)

54959 (NASA-TM-X-2440, pp 387-91) SIMPLE CODE FOR USE IN SHIELDING AND RADIATION-DOSAGE ANALYSES. Wan, C. C. (Hughes Aircraft Co., Los Angeles). Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

A simple code for use in analyses of gamma radiation effects in laminated materials is described. Simple and good geometry is assumed so that all multiple collision and scattering events are excluded from consideration. Buildup factors may be applied to the results of this simplified analysis, when available, to arrive at improved estimates of energy deposition and attenuated intensity for actual materials. The code proper is capable of handling laminates up to six layers. However, for laminates of more than six layers, the same code may be used to incorporate two additional layers at a time, making use of punch-tape outputs from previous computation on all preceding layers. The spectrum of attenuated radiation may be obtained as both printed output and punch tape output as desired. This code is written in "Extended Basic" language, compatible with the GE 265 Time Sharing system. (auth)

54960 (NASA-TM-X-2440, pp 500-11) MEASUREMENTS OF GAMMA-RAY PRODUCTION CROSS SECTIONS FOR SHIELDING MATERIALS OF SPACE NUCLEAR SYSTEMS. Orphan, V. J.; John, Joseph; Hoot, C. G. (Gulf Radiation Tech., San Diego, Calif.). Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

Measurements of secondary gamma-ray production from neutron interactions were made over the entire energy range (thermal to 16 MeV) of interest in shielding applications. A LINAC-pulsed neutron source having a continuous distribution of neutron energies is used in conjunction with high-resolution Ge(Li) gamma-ray spectrometers and the time-of-flight technique. The two-parameter data (gamma-ray energy vs neutron energy) are obtained using a computer-controlled data acquisition system. Two facilities are used in the measurements: A 16-meter facility is used to measure gamma rays from resonant capture of neutrons up to 100 keV. Gamma production cross sections from (n,xy) reactions are measured up to 16 MeV using a 50-meter facility. The epithermal capture gamma-ray yields for both resolved gamma-ray lines and continuum were measured from thermal energies to 100 keV for natural tungsten and ^{238}U, two important candidate shield materials in SNAP reactor systems. Data are presented to illustrate the variation of epithermal capture gamma-ray yields with neutron energy. In the resolved resonance region, the total observed radiated energy was within ±15% of the known binding energy. The gamma-ray production cross sections from (n,xy) reactions were measured for Fe and Al from the threshold energies for inelastic scattering to ~16 MeV. Typical Fe and Al cross sections obtained with high-neutron energy resolution (~1% at 1 MeV) and averaged over broad neutron-energy groups are presented and compared with previous cross-section determinations made using monoenergetic neutron sources. (auth)

54961 (NASA-TM-X-2440, pp 527-8) CALCULATION OF NEUTRON-CAPTURE GAMMA-RAY YIELDS FOR SPACE-SHIELDING APPLICATIONS. Yost, K. J. (Purdue Univ., Lafayette, Ind.). Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

The application of nuclear models to the calculation of neutron-capture and inelastic-scattering gamma yields is discussed. The gamma-ray cascade model describes the cascade process in terms of parameters which either: (1) embody statistical assumptions regarding electric and magnetic multipole transition strengths, level densities, and spin and parity distributions or (2) are fixed by experiment such as measured energies, spin and parity values, and transition probabilities for low-lying states. (auth) (STAR)

54962 (NASA-TM-X-2440, pp 697-705) SHIELD-WEIGHT OPTIMIZATION USING MONTE CARLO TRANSPORT CALCULATIONS. Jordan, Thomas M. (A.R.T. Research Corp., Los Angeles); Wohl, Millard L. Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

An outline is given of the theory used in FASTER-III, a Monte Carlo computer program for the transport of neutrons and gamma rays in complex geometries. The code has the additional capability of calculating the minimum-weight-layered unit shield configuration that will meet a specified dose rate constraint. It includes the treatment of geometric regions bounded by quadratic and quadric surfaces with multiple radiation sources that have a specified space, angle, and energy dependence. The program calculates, using importance sampling, the resulting number and energy fluxes at specified point, surface, and volume detectors. Results are presented for sample problems involving primary neutron and both primary and secondary photon transport in a spherical reactor-shield configuration. These results include the optimization of the shield configuration. (auth)

54963 (NASA-TM-X-2440, pp 832-41) PARAMETRIC FIT TO ELECTRON-TRANSPORT PROPERTIES. Lonergan, J. A.; Shreve, D. C. (Science Applications, Inc., La Jolla, Calif.). Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

Empirical formulations of electron transport properties are presented. Experimental data acquired by several groups over the past few years were gathered and organized. Parametric fits were made to these data so that the following properties of electron transport can be represented by simple functions of atomic number and energy: transmitted electron number, transmitted electron spectra, range, backscatter coefficient, angular distribution, energy deposition, bremsstrahlung intensity and energy spectra, bremsstrahlung angular distribution, and photon attenuation. Though most of the data used to derive the parametric formulas were measured in experiments, some uses were made of results generated using well-developed Monte Carlo techniques. The formulas cover the energy ranges of interest in space-shielding problems (0.1 to 10.0 MeV). These formulas were developed so they could be included in an engineering handbook addressed at the problems of electron radiation in space and its effects. The intent is to provide a simple means of calculating the radiation expected aboard a spacecraft, both on its external surface and behind arbitrary amounts of effective shielding. To satisfy the requirement that the formulas be simple, mathematical rigor based on physical interaction was replaced by convenient fits to thick target data. The formulas are as accurate as these data in most cases and can be easily evaluated without a computer. Procedures for using these formulas in practical situations are suggested. 7 figures. (auth)

54964 (NASA-TM-X-2440, pp 914-21) GAMMA-RAY SHIELDING MEASUREMENTS MADE AT ALTITUDES GREATER THAN 115,000 FEET USING LARGE Ge(Li) DETECTORS. Chapman, G. T. (Oak Ridge National Lab., Tenn.); Cumby, R. P.; Gibbons, J. H.; Macklin, R. L.; Parker, H. W. Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

A series of balloon-flight experiments at altitudes greater than 115,000 feet were conducted to gain information relative to the use of composite shields (passive and/or active) for shielding large-volume, lithium-drifted, germanium (Ge(Li)) detectors used in gamma-ray spectrometers at these altitudes. The measurements were made in the gamma-ray energy region 60 keV to 2 MeV and clearly illustrate the necessity of using a dense gamma-ray shield

protected by an active charged-particle shield for effective shielding of these detectors in the primary cosmic-ray environment. Data showing the pulse-height spectra of the environmental gamma radiation as measured at 5.3 and 3.8 g/cm^2 residual atmosphere with an unshielded diode detector is also presented. (auth)

54965 (ORNL-TM-3871(Rev.)) SDT5. STAINLESS-STEEL BROOMSTICK EXPERIMENT: AN EXPERIMENTAL CHECK OF NEUTRON TOTAL CROSS SECTIONS. Maerker, R. E. Oak Ridge National Lab., Tenn.). Sep 1972. Contract W-7405-eng-26. 25p. (ENDF-170(Rev.)). Dep. NTIS.

The experimental and calculational details for a CSEWG integral data testing shielding experiment are presented. The experiment was designed to test a given set of neutron total cross sections for a type-310 stainless steel in the range 1.2 to 11 MeV. Separation of neutron- and gamma-induced pulses was made by a modified Forte circuit. The unfolding of the pulse-height distributions was accomplished using the FERDoR code. (M.H.R.)

54966 SPATIAL, ANGULAR, AND ENERGY DISTRIBUTION OF FAST NEUTRONS BEHIND TRIPLE LAYER BARRIERS. Elagin, V. B.; Pekarskii, G. Sh. At. Energ. (USSR); 33: No. 1, 590-1(Jul 1972). (In Russian).

The spatial, energy and angular distributions of fast neutrons from a unidirectional, point source beyond a composite three-layer system of Fe/plastic/Fe and W/Al_2O_3/W were studied as functions of the thickness of the separate layers entering into the composite. The Monte Carlo method was employed with a computer in calculations for 2.5- and 14-MeV neutrons and neutrons from a Po–Be source. (K.S.W.)

54967 CREW RADIATION DOSE FROM A HIGH-IMPULSE GAS-CORE NUCLEAR ROCKET PLUME. Masser, Charles C. (Lewis Research Center, Cleveland). J. Spacecraft Rockets; 9: No. 8, 597-601(Aug 1972).

Analytical calculations are performed to determine the radiation dose rate and total dose to the crew of a gas-core nuclear rocket from the fission fragments located throughout the plume volume. The mission chosen is a manned courier trip to the planet Mars. Four round trip times were picked in which the system was optimized so the initial vehicle mass in Earth orbit was minimized for each trip time. They are 80, 100, 150, and 200 days. For the most probable fission-fragment retention time in the reactor of 100 sec, the unshielded radiation dose to a crew located 100 m from the nozzle exit varies from 170 Rem for the 80-day round trip to 38 Rem for the 200 day round trip. For the 80-day round trip the crew must be protected from the radiation dose. Five centimeters of lead shielding would reduce the radiation dose by two orders of magnitude, thereby protecting the crew. (auth)

PHYSICS (SOLID-STATE)

Radiation Effects

Refer also to abstracts 52985, 53229, 53314, and 54874.

54968 (AD-737312) RESEARCH ON THE PHYSICS OF TRANSIENT RADIATION EFFECTS. Final Report, February 2, 1968–October 31, 1971. Azarewicz, Joseph L.; Berger, Robert A.; Cesena, Rodolfo A.; Colwell, Joseph F.; Denson, Raymond (Gulf Radiation Technology, San Diego, Calif.). Feb 1972. Contract DAAG39-68-C-0060. 140p. (GULF-RT-A-10870; HDI-60-3). NTIS.

CHERENKOV RADIATION—use to measure transient free carrier absorption in insulators, feasibility of
ELECTRONS—effects on silicon, (E/T)
—effects on gallium arsenide, (E)
—effects on electric conductivity of naphthalene, (E/T)
GALLIUM ARSENIDES—radiation damage in, electron, (E)
GAMMA RADIATION—effects on electric properties of polystyrene capacitors with metal electrodes, (E)
NAPHTHALENE—radioinduced electric conductivity of, electron, (E/T)
NEUTRONS—effects on silicon, (E/T)
SILICON—radiation damage in, neutron and electron, (E/T)
STYRENE POLYMERS—radioinduced carriers in capacitors of, γ, (E)

54969 (AECL-4130) COMPUTER PROGRAM TO CALCULATE DAMAGE DISTRIBUTIONS IN ION-BOMBARDED TARGETS. Caillibot, P. F.; Hunt, C. E. L. (Atomic Energy of Canada Ltd., Chalk River (Ontario), Chalk River Nuclear Labs.). May 1972. 52p. Dep. NTIS (U. S. Sales Only). AECL $1.50.

Simulation of fission damage by means of ion bombardment eliminates induced radioactivity and reduces experimental time by several orders of magnitude. However, the conditions under which such bombardments are to be done must be carefully determined. The mathematical model developed by Lindhard et al., based on a Thomas–Fermi potential between the atoms, was used. The required calculations are time-consuming; therefore, a computer program, IONR, was written. It calculates the damage profile produced in a target by any projectile. For a range of energies it will calculate the relative bombardment times to approximate a homogeneous damage profile up to the maximum penetration depth. Results are produced both as graphs and tables. An example is presented for argon bombardment of zirconium. (auth)

54970 (CEA-CONF-1890) COMPUTER SIMULATION IN RADIATION DAMAGE STUDIES. Torrens, Ian M. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1972. 32p. (CONF-720423-4). Dep. NTIS (U. S. Sales Only).

From first European conference on computational physics; Geneva, Switzerland (10 Apr 1972).

The application of atomistic computer simulation to problems involving radiation damage and lattice defects in crystalline solids is discussed. The different topics include static defect configurational simulations, molecular dynamics of thermal motion, low-energy atomic collision events, high-energy atomic displacement cascades, and the thermal annealing of concentrations of defects in a lattice region. The methods described are criticized from the point of view of the assumed physical models, and their capabilities and limitations are indicated. Emphasis is on techniques used rather than on results obtained. (auth)

54971 (CEA-R-4313) ELECTROLUMINESCENT DIODES FORMATION IN ION IMPLANTED ZINC TELLURIDE. Marine, Jean (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Jun 1972. 101p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

Radiative-recombination mechanisms and minority-carrier injection devices are reviewed, and ion implantation is presented as a doping method in order to achieve electroluminescent diodes in a nonstoichiometric material such as ZnTe. The implanted layer is mainly characterized by: the secondary ion-emission microanalyzer to determine the profile of implanted impurities; the hot probe to determine the conductivity type; the photoluminescence to bring out the levels due to impurities; and the sheet-resistivity measurements. All these measurements show that it is possible to get an n-type layer in a boron- or chlorine-implanted ZnTe. For the diodes achieved, current–voltage characteristic and junction capacitance in reverse-bias measurements show that they were p–i–n type. Two assumptions are suggested to explain the presence of an intrinsic layer between the implanted region (n-type) and the substrate (p-type). Finally, the electroluminescence of these diodes showed that the presence of oxygen gives a red light emission at 6750 Å and, when the material is oxygen-free, the light emission is green at 5580 Å with a quantum efficiency of 0.6% at 300°K. (auth)

54972 (COO-2119-2) EXPERIMENTS IN HIGH-VOLTAGE ELECTRON MICROSCOPY. Progress Report, October 31, 1972–July 31, 1973. Mitchell, T. E.; Das, G.; Kenik, E.; Sklad, P. (Case Western Reserve Univ., Cleveland, Ohio. Div. of Metallurgy and Materials Science). 1 Aug 1972. Contract AT(11-1)-2119. 23p. Dep. NTIS.

Experiments using high-voltage electron microscopy are described that take advantage of the high-resolution selected-area diffraction (SAD) and in-situ electron-radiation-damage capabilities. SAD experiments show that the error distance is 30 times better at 650 kV than at 100 kV; the error distance increases in proportion to the cube of the Bragg angle as expected and is better than 1000 Å for Bragg plane spacings greater than 0.5 Å. Electron-irradiation damage was observed in copper, stainless steel, nickel, vanadium, graphite, and quartz as a function of time and temperature. In Cu, stainless steel, and Ni, faulted interstitial loops are formed that grow, unfault, and then either glide out of the foil or form a dislocation network with other prismatic loops. Void formation was observed in Cu and stainless steel after long doses at high temperatures, using a prior low-temperature irradiation. Radiation-induced carbide precipitation also occurs in stainless steel. In quartz black spot defects are formed, after which the irradiated area becomes amorphous. (auth)

54973 (FRNC-TH-210) PRODUCTION OF HIGH DEFECT CONCENTRATIONS IN ALKALI HALIDES BY ELECTRON BOMBARDMENT. Herrmann, Friedrich (Lyon Univ. (France)). 1971. 80p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

High-defect densities were produced (10^{19} centers/cm^3) by irradiating alkali-metal halide crystals (KCl, KBr, KI, NaCl, and LiF) with electron beams (10 to 50 keV). Optical absorption measurements were used to determine the color-center density. The growth curve represents the variation in the color-center concentration (or optical density) as a function of the radiation dose (or irradiation time). The value of the exponent in the expression linking the electron path to the primary electron energy was determined. It is shown that it is possible to relate the local increase in concentration to an increase in optical density for a nonuniformly colored crystal. The changes in the absorption bands (F, M, and V) in various substances at different temperatures were compared. The growth rate for F centers decreases uniformly during irradiation. A model was developed explaining this decay; this model can be simulated by computer. Some experiments carried out with LiF enabled an upper limit to be established for the threshold energy for the displacement of a cation (1.64 eV). (France)

54974 (LYCEN-7228) CHANNELING OF LIGHT IONS OF 0.5 TO 2 MeV THROUGH A FEW-HUNDRED ANGSTROM-THICK GOLD CRYSTALS. Poizat, J. C.; Remillieux, J. (Lyon Univ. (France). Institut de Physique Nucleaire). May 1972. 37p. (In French). Dep. NTIS (U. S. Sales Only).

A technique to obtain a few hundred-Å-thick self-supporting gold crystals is described. These crystals were used to perform three channeling experiments with 0.5- to 2-MeV light ions: The wide-angle scattering probability as a function of the distance from the crystal surface was studied for an incident beam of particles in the planar and axial directions. The influence of channeling on the light emission from crystal-excited atomic beams was investigated. A strong channeling effect was found on the probability of transmission of a molecular beam of H_2^+ ions through a thin crystal. (France)

54975 (RT/EL-(72)2) MEASURE OF THE PHOTOVOLTAIC EFFECT IN SILICON DIODES OBTAINED THROUGH IMPLANTATION OF IONS. Russo, M.; Sano, A.; Testa, M. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 22 Feb 1972. 77p. (In Italian). Dep. NTIS (U. S. Sales Only).

Results of a study on the photovoltaic effect in Si diodes obtained by the ion implantation technique are reported. The aim of the work was to weigh the possibility of measurement, on the basis of this effect, of some parameters such as the junction depth, minority-carrier diffusion length, etc. Results show that it is pos-

sible to measure the diffusion length of minority carriers in the bulk, by means of the near-infrared spectral response. To obtain the other parameters, it is necessary to utilize also different kinds of measurements. This study also showed that, in the bulk, in proximity of the junction, there was a damage not attributable to the implantation technique. (auth)

54976 ION IMPLANTATION FACILITY AT ORSAY. Chaumont, J.; Baran-Marzak, M.; Camplan, J.; Meunier, R.; Sarrouy, J. L. (CNRS, Orsay, France). pp 105-11 of International Colloquium on the Application of Vacuum Techniques to the Semiconductor Industry, Electronic, and Microelectronic Components. Paris; Societe Francaise des Ingenieurs et Techniciens du Vide (1971).

From third international symposium on the application of vacuum techniques in semiconductor industry, electronic components, and microelectronics; Versailles, France (13 Sep 1971). See CONF-710932.

The various parts of the ion implantation facility at Orsay are described. Emphasis is given to the ion source and the beam extraction system. Preliminary results obtained for ion implantation are given. (France)

54977 EXPERIMENTAL ARRANGEMENT FOR INVESTIGATION OF SINGLE CRYSTALS BY MEANS OF FAST IONS. Haan, G.; Flagmeyer, R.; Geist, V.; Mende, A.; Lehmann, D. (Karl Marx Univ., Leipzig). Exp. Tech. Phys.; 20: No. 1, 67-80(1972). (In German).

A detailed description is given of a measuring equipment for channeling and blocking experiments with a brief introduction to these effects. The main part of the work is concerned with the description and the physical reasons of special elements such as collimator, beam current measurement, crystal mounting, cooling device, and so on. Results are given of first experimental tests with a tungsten single crystal. (auth)

54978 PHONON SCATTERING BY VANADIUM IONS IN Al_2O_3. de Goer, A. M.; Devismes, N. (CEN, Grenoble, France). J. Phys. Chem. Solids; 33: No. 9, 1785-93(Sep 1972).

Thermal conductivity measurements were made between 1.3 and 150°K on several vanadium-doped Al_2O_3 single crystals, in their as-received state and after γ irradiation. One Ti-doped sample was also measured. The results are well explained by ascribing the resonant phonon scattering observed to transitions between low-lying energy levels of V^{4+} and Ti^{3+} ions. A good fit of the curves was obtained using Callaway's (1959) method. Resonant scattering is described by an additional phonon relaxation time of the form: $[\tau_2^{-1} = D_1(\omega^4/(\omega^2 - \omega_1^2)^2) + (D_2/D_1)\ (\omega^4/(\omega^2 - \omega_2^2)^2]$ where $\hbar\omega_1 = \delta_1$ and $\hbar\omega_2 = \delta_2$ are known, and D_2/D_1 is kept constant for all V-doped specimens. From these quantitative analysis and coupled EPR measurements, it was possible to estimate that only 1% of the total vanadium content was in the V^{4+} valence state in all as-received samples. Hence the great sensitivity of low-temperature thermal conductivity to the presence of ions subjected to a dynamic Jahn–Teller effect is confirmed in the case of these Kramers d^1 ions. (auth)

54979 OBSERVATION OF DISLOCATION LOOPS IN GADOLINIUM THIN SINGLE CRYSTAL. Srivastva, M. M.; Srivastava, O. N. (Banaras Hindu Univ., India). Jap. J. Appl. Phys.; 11: No. 9, 1237-8(Sep 1972).

Dislocation loops were found to form in hcp Gd thin single-crystal films in an electron microscope. Tiny dot-like features developed, turning into dislocation loops which were often hexagonal-shaped. Stacking fault tetrahedra were also observed. These loops and tetrahedra are due to the aggregation of point defects produced by the bombardment. (D.L.C.)

54980 INTERSTITIAL HALOGEN CENTERS IN X-IRRADIATED CsBr. Chowdari, B. V. R.; Itoh, N. (Nagoya Univ., Japan). J. Phys. Chem. Solids; 33: No. 9, 1773-83(Sep 1972).

Interstitial halogen centers in CsBr produced by x-irradiation at 4.2 and 77°K were studied and assignments of several absorption bands associated with these centers were made. The most prominent bands formed by x irradiation at 4.2°K were the F and H bands. Besides the known two σ-polarized absorption bands associated with the H center, another weakly π-polarized band at 1062 nm was found. The next prominent bands formed at 4.2°K were the α and I bands whose peak positions are at 205 and 236 nm, respectively. X-irradiation at 4.2°K also caused an absorption band at 324 nm due to H^1 center. It is shown that the height of H^1 band is proportional to the square of the height of the H band, suggesting that the centers associated with the H^1 band are di-H-centers. Optical and thermal bleaching of the H bands causes the increase in H^1 band. The study of the thermal annealing properties of H^1 band suggests the composite nature of the band. After the H bands were thermally bleached, three absorption bands at 425, 502 and 1060 nm were found to grow whose source might be the interstitial atom associated with an impurity. X-irradiation at 77°K produced the F and V_4 centers, the latter of which has an absorption band at 276 nm. The V_4 center has ⟨100⟩ orientation. The formation and thermal bleaching properties of the H^1 and V_4 bands are compared. (auth)

54981 FAST-NEUTRON-COMPENSATED n-GERMANIUM AS A MODEL OF AMORPHOUS SEMICONDUCTORS. Gadzhiev, A. R.; Ryvkin, S. M.; Shlimak, I. S. (Ioffe Inst. of Physics, and Tech., Leningrad). JETP Lett. (USSR) (Engl. Transl.); 15: No. 10, 428-31(20 May 1972).

Translated from Zh. Eksp. Teor. Fiz.; Pis'ma Red.; 15: No. 10, 605-8(20 May 1972).

A model of an amorphous semiconductor can be produced by producing a random distribution of point defects. This was investigated by irradiating As-doped n-type Ge with fast neutrons, which produce spherical disordered regions of p-type character. The spatial variation of the potential is discussed, and it is shown that the conductivity mechanism should be tunneling over states closer and closer to the Fermi level. Experimental results confirm expectations: the conductivity decreased and acquired an activation character with irradiation dose, Mott's law is satisfied, and the current-voltage characteristic has a S-shape with a considerable negative differential resistance section. (D.L.C.)

54982 TUNNEL ASSISTED HOPPING IN NEUTRON IRRADIATED GALLIUM ARSENIDE. Coates, R.; Mitchell, E. W. J. (Univ. of Reading, Eng.). J. Phys., C (London); 5: No. 10, L113-18(25 May 1972).

The resistivity against dose curve in neutron-irradiated gallium arsenide shows an anomaly. At doses in excess of 10^{17} n cm^{-2} the resistivity decreases with dose. The temperature dependence of resistivity indicates that the mechanism of conduction at high doses is tunnel-assisted hopping. Since the structural studies reveal that even at the highest dose the material remains substantially crystalline, the tunnel-assisted hopping is considered to occur via defect energy levels. (auth)

54983 COMPARISON OF DEFECT CENTRES FORMED IN OXIDES BY EXPLOSIVE SHOCKING AND HIGH-ENERGY RADIATION. Nelson, R. L. (Atomic Energy Research Establishment, Harwell, Eng.); Hartley, D. B. J. Chem. Soc., Dalton Trans.; No. 15, 1596-1603(1972).

ESR and reflectance spectroscopic techniques were used to compare point defects present in MgO, ZnO, and SiO_2 both after explosive shocking and after irradiation with high-energy γ rays, electrons, and neutrons. A high correlation of shocking with irradiation exists in MgO, none in SiO_2, and ZnO occupies an intermediate position. In MgO, explosive shocking induced ionization with trapping of electrons at existing defects and produced vacancy defects (F^+ and F_2^+) by displacement of lattice ions. In SiO_2 none of these effects were present but there is evidence of contamination with carbon as a result of the explosion. This significant difference in behavior to shocking is reflected in the different physical properties of these oxides, but could also be brought about by a suitable choice of explosion conditions. (auth)

54984 LOCALIZED VIBRATIONAL MODES IN GALLIUM ARSENIDE CONTAINING SILICON AND BORON. Thompson, F.; Newman, R. C. (Univ. of Reading, Eng.). J. Phys., C (London); 5: No. 15, 1999-2010(7 Aug 1972).

A comparison was made between the infrared local-mode absorption spectra of boat-grown and pulled crystals of GaAs:Si. The samples were compensated either by electron or neutron irradiation or by copper diffusion. Boron is present in the pulled material and previously unreported lines are assigned as follows: ^{11}B(Ga) (517.0 cm^{-1}), ^{10}B(Ga) (540.2 cm^{-1}), B(Ga)–Si(As) pairs (349.0, 570.9, 596.0, 661.0, and 684.8 cm^{-1}). Two further lines at 762.7 and 796.0 cm^{-1} may be due to interstitial boron atoms produced by the irradiations. It is thought that other lines may be due to the center B(Ga)–Si(As)–Si(Ga). (auth)

54985 DIFFUSION OF POINT DEFECTS TO THE FOIL SURFACE DURING IRRADIATION DAMAGE EXPERIMENTS IN THE HIGH VOLTAGE ELECTRON MICROSCOPE. Foreman, A. J. E. (Atomic Energy Research Establishment, Harwell, Eng.). Radiat. Eff.; 14: No. 3-4, 175-9(Jun 1972).

The high-voltage electron microscope can be used to simultaneously produce and observe irradiation damage structures in thin foils of many materials, including in particular the formation of voidage at elevated temperatures. In such experiments some of the vacancies and interstitial atoms produced in the damage process will be lost by diffusion to the foil surface, so that the results may not be characteristic of the bulk material if the foil is too thin. The steady-state point defect concentrations built up in a thin foil were computed as a function of the foil thickness, defect production rate, and vacancy jump frequency, taking into account the

effect of the mutual recombination of vacancies and interstitial atoms. The coupled diffusion equations for the point defect concentrations were solved numerically for a thin foil, assuming the foil surfaces to be perfect sinks for the point defects, and the results for any material expressed in terms of a single dimensionless parameter. The computations show that for a foil containing few internal sinks, which is the most demanding case, defect concentrations typical of the bulk material can be achieved within an appreciable fraction of a 0.5-μm thick foil, for temperatures up to about one-half the absolute melting temperature. The loss of point defects to the foil surface is shown to be further reduced when the foil contains a high density of internal sinks (e.g. dislocations, voids, precipitate particles) and there is an additional improvement at very high temperatures due to the effect of thermal vacancies. (auth)

54986 COMPUTER CALCULATIONS OF SHEET RESISTANCE OF n- AND p-TYPE IMPLANTATIONS IN SILICON. Smith, B. J.; Stephen, J. (Atomic Energy Research Establishment, Harwell, Eng.). Radiat. Eff.; 14: No. 3-4, 181-4(Jun 1972).

Computer calculations of sheet resistance of ion-implanted layers are described. For Gaussian doping profiles, the sheet resistance depends on the surface concentration and electrical conductivity of the implanted impurity and the standard deviation in the projected ion range. Universal curves were produced from which the sheet resistance of any implanted silicon layer could be derived, provided these parameters were known, and assuming that all the implanted atoms contribute to the electrical conductivity. (auth)

54987 LOCATION OF DIFFUSION-DOPED GOLD ATOMS IN SILICON BY MEANS OF CHANNELING. Iue, N.; Matsunami, N.; Morita, K.; (and others) (Nagoya Univ., Japan). Radiat. Eff.; 14: No. 3-4, 191-3(Jun 1972).

The lattice location of gold atoms diffused into silicon is determined using the channeling of He^+ ions. It is shown that the gold atoms that accumulate at the back surface are located at the hexagonal interstitial sites. (UK)

54988 DECHANNELING OF HEAVY CHARGED PARTICLES IN DIAMOND LATTICES. Morita, K. (Nagoya Univ., Japan). Radiat. Eff.; 14: No. 3-4, 195-202(Jun 1972).

Dechanneling rates of 1.5-MeV protons, deuterons, and helium ions in the (100) axial and (110) planar channels were obtained by analyzing their backscattering energy spectra for the aligned and random directions. The experimental dechanneling rates in the axial channels, inclusive of those in Si, GaP, NaCl, KCl, and KBr single crystals, followed a universal expression for the dechanneling derived using the diffusion model according to Lindhard's theory. Comparing with the theory, the contribution of the electronic collisions to the dechanneling was separated from the contribution of the nuclear collisions. The experimental value of the electronic contribution agreed well with the theoretical value. The experimental value of the nuclear contribution was smaller than the theoretical value by a factor of about 3. The discrepancy between the experimental and the theoretical value of the nuclear contribution is discussed. (auth)

54989 ELECTRICAL RESISTIVITY INCREASE RATES IN Fe–C AND Fe–N SOLID SOLUTIONS DURING NEUTRON IRRADIATION AT 4.5 K. Wagenblast, H.; Schwerer, F. C.; Horak, J. A. (United States Steel Corp., Monroeville, Pa.). Radiat. Eff.; 14: No. 3-4, 203-13(Jun 1972).

A series of α-iron specimens containing carbon and nitrogen in interstitial solid solution were irradiated simultaneously at 4.5°K with fast neutrons to a fluence of 4.7×10^{17} n/cm^2 with E > 0.1 MeV. In-situ electrical resistivity measurements during irradiation showed that the apparent damage rates were dependent on the C or N concentration. In particular, the value of the initial resistivity increment per unit flux (δ), passed through a minimum value at 0.1 at. % N and became larger than the value for pure iron above 0.14 at. % N. The results can be explained qualitatively as interstitial impurity-induced differences in production rates and dispersion of defects or semi-quantitatively as defect-induced deviations from Matthiessen's rule. (auth)

54990 ELECTRON RADIATION DAMAGE NEAR THE THRESHOLD ENERGY IN ALUMINIUM. Wolfenden, A. (Oak Ridge National Lab., Tenn.). Radiat. Eff.; 14: No. 3-4, 225-9(Jun 1972).

Foils of high-purity aluminum, both with and without preinjection of about 10 at. ppM helium, were electron-irradiated in the electron microscope operating at voltages in the range 150 to 200 keV. In the helium-doped aluminum, electron damage in the form of black spots was produced at 150 keV after about 90 min irradiation time. They showed contrast effects characteristic of dislocation loops. No such spotlike damage was observed at 150 keV in the uninjected aluminum for bombardment times over 4 hr. Damage was observed in both pre-injected and uninjected specimens at 175 and 200 keV. Possible mechanisms for subthreshold damage are examined to see which account for the electron damage observed below the accepted threshold of about 170 keV for aluminum. (auth)

54991 PROPERTIES OF PROTON-IRRADIATED DIAMOND. Ananthanarayanan, K. P.; Borer, W. J.; Plendl, H. S.; Gielisse, P. J. (Univ. of Rhode Island, Kingston). Radiat. Eff.; 14: No. 3-4, 245-8(Jun 1972).

Properties of type I diamond were investigated before and after irradiation with 17.0- and 18.3-MeV protons. The optical absorption edge is essentially unchanged. The infrared absorption spectrum shows a strong additional peak at 6.92 μm. A Raman line shift of 4 cm^{-1} indicates an increase of 0.0032 Å in the lattice constant. (auth)

54992 INFLUENCE OF ELECTRON IRRADIATION ON CdS THIN FILMS. Spinulescu, I.; Baltateanu, N. (Univ., Bucharest). Radiat. Eff.; 14: No. 3-4, 257-9(Jun 1972).

The effect of 3-MeV electrons on the crystallographic orientation of cadmium sulfide thin films is studied using electron diffraction. (UK)

54993 FLUX EFFECTS ON DAMAGE IN GaAs AS MEASURED BY THE CHANNELLING OF ^{85}Kr. Grant, W. A.; Baruah, J. N. (Univ. of Salford, Eng.). Radiat. Eff.; 14: No. 3-4, 261-2 (Jun 1972).

The ranges of ions implanted into semiconductors has been extensively studied but little attention has been paid to the dose rate used during the implantation. The influence of dose rate of damage to gallium arsenide single crystals using ^{84}Kr and ^{85}Kr ions is studied. It is concluded that the degree of damage is dependent on the dose rate, the dose dependence of damage will influence the distribution profile of implanted ions, and the dechanneling of heavy ions can be used as a measure of damage. (UK)

54994 PRECIPITATION OF PHOSPHOROUS IN ION IMPLANTED SILICON. Seshan, K.; Washburn, J. Radiat. Eff.; 14: No. 3-4, 267-70(Jun 1972).

Electron microscope observations on phosphorous-ion-implanted ρ-silicon after annealing at 800°C are reported. Heating for $\frac{1}{2}$ hour after implantation of 2×10^{14} ions/cm^2 at 20°C was found to produce dislocation loops and rod-like defects similar to those observed in boron-implanted silicon. It was concluded that the rod-shaped defects were associated with phosphorous precipitation. (auth)

54995 NATURE OF ROD-LIKE DEFECTS OBSERVED IN BORON IRRADIATED SILICON. Madden, P. K.; Davidson, S. M. (Oxford Univ.). Radiat. Eff.; 14 No. 3-4, 271-3(Jun 1972).

The rod-like defects appearing in silicon irradiated with 40-keV B^+ ions were studied by electron microscopy. It is suggested that the rods can best be explained on a model of an elongated faulted dislocation loop, extrinsic in character with an α/k (100) Burgers vector. (UK)

54996 OPTICAL ABSORPTION BANDS OF COLOR CENTERS IN IRRADIATED ANTHRACENE SINGLE CRYSTALS AT LOW TEMPERATURES. Matsuyama, Tomochika; Yamaoka, Hitoshi; Okamura, Seizo (Kyoto Univ., Osaka). Radiat. Eff.; 14: No. 3-4, 275-6(Jun 1972).

Anthracene single crystals were irradiated at 77°K by ^{60}Co gamma rays and the optical absorption spectrum measured. The effect of warming to 399°K on the absorption spectrum is shown. (UK)

54997 SIMILARITIES OF THE IONIZATION EFFECTS AND ANNEALING IN P-TYPE AND CONVERTED N-TYPE Ge IRRADIATED WITH ELECTRONS AT 85°K. Kraitchinskii, A.; Rzewuski, H.; Suski, J.; Werner, Z. (Inst. of Nuclear Research, Warsaw). Radiat. Eff.; 14: No. 3-4, 277-8(Jun 1972).

The annealing behavior of p-type Ge and n-type Ge converted into p-type by electron irradiation is studied. It is concluded that as both types of Ge show the same trapping effects and annealing behavior, the behavior of irradiated Ge can be attributed to some intrinsic type of defect. (UK)

54998 EFFECTS OF GAMMA RADIATION ON PHOTOCURRENT-VOLTAGE CHARACTERISTICS OF CdS FILMS. Kao, K. C.; Sadhu, A. (Univ. of Manitoba, Winnipeg, Can.). Radiat. Eff.; 14: No. 3-4, 279-80(Jun 1972).

Cadmium sulfide films were irradiated with gamma rays from a ^{60}Co source while illuminated with sodium light. The threshold field for the onset of high-field photocurrent saturation increased and the saturation current decreased with increasing radiation dose. It was also found that for a given dose and applied voltage

the change in the photocurrent due to irradiation for CdS films was much greater than for CdS crystals. (UK)

54999 TEMPERATURE DEPENDENCE OF VIBRONIC SPECTRA IN IRRADIATED SILICON. Hare, A. P. G.; Davies, G.; Collins, A. T. (King's Coll., London). J. Phys., C (London): 5: No. 11, 1265-76(12 Jun 1972).

Crucible-grown and high-purity floating-zone silicon specimens were irradiated at room temperature with γ rays. High-resolution cathodoluminescence spectra of the vibronic bands with zero-phonon lines at 0.717, 0.724, 0.790, 0.795, 0.898, and 0.969 eV are given. The widths and energies of these lines, and the intensities of the 0.790, 0.795, and 0.969-eV lines relative to the total intensities of their associated bands, are given in the temperature range 25 to 75°K. These data are discussed in terms of the theory of linear and quadratic electron–phonon coupling in the adiabatic approximation, using Debye spectra of coupled phonons and, for the 0.790, 0.795 and 0.969-eV lines, densities of coupled phonons derived from the emission band shapes. The theory gives a self-consistency between the spectral band shapes and the widths and energies of the zero-phonon lines, but does not satisfactorily fit the temperature dependence of the intensities of the zero-phonon lines. It is not known whether the failure of the theory is due to a Jahn–Teller effect (no absorption at the centers has been detected) or to the coupling by the electron–phonon interaction of electronic states whose energies are not greatly separated compared with the phonon energies involved. (auth)

55000 LIFETIMES OF FAST RECOMBINATION LUMINESCENCE TRANSITIONS IN ALKALI HALIDES. Blair, I. M.; Pooley, D.; Smith, D. (Atomic Energy Research Establishment, Harwell, Eng.). J. Phys., C (London): 5: No. 12, 1537-52(26 Jun 1972).

Measurements were made of the lifetimes of the fast recombination luminescence transitions in alkali metal halides. The luminescence was excited by 2-MeV proton pulses about 2 ns wide and the lifetimes measured by the technique of single photon counting. All alkali metal halides in which fast luminescence occurs were studied at 5 and 77°K. The lifetimes of the major components lie in the range 1 to 4 ns, and in many cases a second component with a lifetime of about 10 to 20 ns is evident. The temperature dependence of luminescence in NaCl, KBr, and KI was measured and compared with the behavior of the slow luminescence in these crystals. A new model for the electronic structure of the excited states involved in recombination luminescence is proposed and compared with the model based on the inert gas molecule. (auth)

55001 VIBRATIONAL AND ELECTRONIC PROPERTIES OF $Co(CN)_6^{3-}$ DOPED IN ALKALI HALIDES. Jain, S. C.; Warrier, A. V. R. (Solid State Physics Lab., Delhi). J. Phys., C (London): 5: No. 12, 1511-18(26 Jun 1972).

The ir spectra of solution-grown crystals of NaCl and KCl doped with $Co(CN)_6^{3-}$ show a multiplet in the Γ_8 stretch frequency region of CN^-. Apparently, the multiplet consists of four components in NaCl and three in KCl. However, a detailed examination of the results shows that the multiplet consists of several components due to different site symmetries in which $Co(CN)_6^{3-}$ is present in the crystal. The most probable symmetries are D_{2h} and D_4. On x irradiation the multiplet characteristic of $Co(CN)_6^{3-}$ decreases in intensity and a new multiplet characteristic of $Co(CN)_6^{4-}$ and a single line characteristic of $Co(CN)_6^{5-}$ appear on the low-energy side. On heating the crystals, irreversible changes in the spectra occur. The spectra consist of many lines, but only the line corresponding to NCO^- could be identified. The electronic spectra of the impurity show seven bands in the wavelength region 600 to 200 nm as compared with only three bands observed in the solution in this region. The bands are interpreted as being due to transitions of the split components of crystal field levels in O_h symmetry. Both peak positions and intensities are consistent with the assignment. (auth)

55002 ANALYSIS OF THE EFFECTS OF ELECTRON DAMAGE ON THE BOUND-TO-BOUND EMISSION INTENSITY OF CADMIUM SULPHIDE. Radford, C. J.; Hagston, W. E.; Bryant, F. J. (Univ. of Hull, Eng.). J. Phys., C (London): 5: No. 12, 1526-36(26 Jun 1972).

Observation of the changes produced in donor–acceptor pair cathodoluminescence emission intensities of as-grown, cadmium-fired, and sulfur-fired cadmium sulfide samples by electron radiation damage allows an estimate to be made of the initial donor concentration present and of the fraction of pairs excited. This analysis also shows that an increase in the donor or acceptor concentration need not necessarily result in an enhancement of the donor–acceptor pair luminescence emission intensity and, under certain circumstances, could lead to a reduction in emission intensity. The observations provide confirmation of this effect. (auth)

55003 SURFACE AND DEPTH DISTRIBUTION DAMAGE OF IONS IN SILICON AS SEEN WITH AN ELECTRON MICROSCOPE. Bertolotti, M.; Sette, D.; Stagni, L.; Vitali, G. (Univ., Rome). Radiat. Eff.: 15: No. 1-2, 31-5(Jul 1972).

The localized damage around ion tracks at the surface of an implanted semiconductor is studied by electron microscopy. It is shown that it is possible to see not only the produced damage but also to follow the depth distribution of the damage under the implanted semiconductor surface. (UK)

55004 PROTON AND FAST NEUTRON DAMAGE STUDIES IN Si AND Ge USING CHANNELING. Marcus, Gail H. (Massachusetts Inst. of Tech., Cambridge); Olson, N. Thomas; Ryan, Jean L. Radiat. Eff.; 15: No. 1-2, 51-6(Jul 1972).

The orientation dependence of the backscattering yield (channeling) of 1.0-MeV protons was used to investigate fast-neutron-induced lattice damage in silicon and germanium single crystals. The measurements were made at room temperature and for protons incident in (110) crystal directions. The reactor irradiations were made, using a fast neutron flux $\phi = 3.3 \times 10^{13}$ n/cm^2-sec (>0.1 MeV) at 60°C, to total exposures (ϕt) between 2.1×10^{17} and 3.4×10^{19} n/cm^2. The per cent of lattice atoms displaced was not linear with neutron exposure. The displacements rose rapidly with exposure initially, then assumed a very slow rise having a dependence on neutron exposure of $(\phi t)^{0.1}$. This appears to be some modification of an exponential saturation mechanism. It agrees qualitatively with a thermal annealing mechanism, which predicts a flux-dependent (i.e., rate of defect introduction dependent) saturation value occurring even for room-temperature irradiations. (auth)

55005 CORRELATED RECOVERY KINETICS. Peak, D.; Brosious, P.; Lee, Y. H.; (and others) (State Univ. of New York, Albany). Radiat. Eff.; 15: No. 1-2, 61-72(Jul 1972).

Diffusion-controlled correlated recovery kinetics are compared for the continuum and discrete lattice treatments. Specific results are given for the simple cubic, face-centered cubic, body-centered cubic, and diamond lattices. It is concluded that samples with anisotropic damage distributions created by irradiation in different crystallographic directions will not exhibit substantial differences in their correlated recovery, but it is argued that for small capture volumes and for the treatment of the early recovery times, the discrete treatment is required. (auth)

55006 NEW EPR SPECTRA IN NEUTRON-IRRADIATED SILICON. Lee, Y. H.; Kim, Y. M.; Corbett, J. W. (State Univ. of New York, Albany). Radiat. Eff.; 15: No. 1-2, 77-84(Jul 1972).

Six new EPR spectra reported are apparently due to intrinsic defects created in the neutron irradiation and, in some cases, annealing of silicon. In addition, a spectrum similar to, but distinct from, that due to the vacancy–phosphorus center is reported. Some tentative defect models are discussed to emphasize the features of the spectra, but more detailed studies are required to establish the identity of the defects giving rise to these spectra. (auth)

55007 THEORY OF FLUX PEAKING EFFECT IN CHANNELING. Kumakhov, M. A. (Moscow State Univ.). Radiat. Eff.; 15: No. 1-2, 85-99(Jul 1972).

The redistribution of the axial- and planar-channeled ion flux was examined. General formulae describing the flux peaking effect were obtained and the main factors on which the effect depends were examined. Backscattering experiments were also analyzed. (auth)

55008 INFLUENCE OF THE INCIDENCE ANGLE ON IRON AND COPPER SURFACE MICROTOPOGRAPHY INDUCED BY ION BOMBARDMENT. Teodorescu, I. A.; Vasiliu, F. (Institutul de Fizica, Atomica, Bucharest). Radiat. Eff.; 15: No. 1-2, 101-13(Jul 1972).

The influence of argon-ion bombardment on iron and copper surface microtropography was studied. Thermal etching revealed a regular microtopography with different oriented grain structure. The surface microrelief is characterized by pyramidal growths at the points where the dislocations intersect the iron surface or by terraced microstructures, depending on the crystallographic orientation on the copper surface. A simple model is introduced for the estimation of the bombardment time necessary for complete erosion of the pyramids on the iron surface. (auth)

55009 ELECTRONIC STOPPING MEASUREMENTS OF CHARGED-PARTICLES IN RADIOPHOTOLUMINESCENT GLASS. Arnold, G. W.; Vook, F. L. (Sandia Labs., Albuquerque, N. Mex.). Radiat. Eff.; 14: No. 3-4, 157-63(Jun 1972).

Measurements were made of the radiophotoluminescence generated in silver-activated phosphate glass by the electronic energy

losses of 200- to 400-keV ions (H^+, He^+, O^+) incident on the glass. Measurements of luminescence growth as a function of energy into electronic processes per unit volume showed a departure from linearity above ~10^{18} keV/cm^3. For lower deposition values, detailed measurements of the integral depth distribution of luminescence intensity were made as material was removed by vibratory polishing. The measured depth distributions compared favorably to the integral depth distributions of electronic energy losses predicted by LSS theory (He^+ and O^+) and to experimental values of thin film losses (H^+). These comparisons indicated that the luminescent centers were formed in the glass close to ($\leq 10^3$ Å) the point of the initial deposition of electronic energy. (auth)

55010 RECOVERY OF ELECTRON-IRRADIATED PLATINUM. 1. STAGE 1 ANNEALING. Dibbert, H. J.; Sonnenberg, K.; Schilling, W.; Dedek, U. (Kernforschungsanlage, Juelich, Ger.). Radiat. Eff.; 15: No. 1-2, 115-27(Jul 1972).

By means of electrical resistivity measurements, the recovery in stage I of electron-irradiated Pt was studied. The effects of irradiation dose, electron energy, radiation doping, and doping with dilute concentrations of Au atoms on the annealing structure were investigated. The recovery in substages I_A, I_B, and I_C was not influenced by irradiation dose and doping agents, in agreement with the model of close Frenkel-pair recombination in these stages. Substage I_E was strongly and substage I_D was moderately modified by variation of radiation dose and the addition of doping agents. This and the equal values of the activation energies confirmed the model of correlated and uncorrelated recovery of free migrating interstitials in these stages. (auth)

55011 RECOVERY OF ELECTRON-IRRADIATED PLATINUM. PART 2. COMPARISON OF STAGE 1 ANNEALING WITH THEORIES FOR 3- AND 1-DIMENSIONAL MIGRATION OF INTERSTITIALS. Sonnenberg, K.; Schilling, W.; Dibbert, H. J.; Mika, K.; Schoeder, K. (Kernforschungsanlage, Juelich, Ger.). Radiat. Eff.; 15: No. 1-2, 129-41(Jul 1972).

The experimental data for the time and dose and energy dependence of the recovery in substage I_D and I_E of electron-irradiated Pt were compared critically with the results of full diffusional treatments of the correlated plus uncorrelated recovery of interstitial–vacancy pairs. Excellent agreement was obtained if in the theoretical treatment three-dimensional migration of interstitials was assumed. In contrast to this, the assumption of one-dimensional interstitial migration (off-line crowdion model) led to serious disagreements with the observed dose dependence of stage I_E. In addition, the strong dependence of the recovery structure in substage I_D and I_E on the energy of the bombarding electrons predicted by the crowdion model was not observed experimentally. (auth)

55012 DESTRUCTION OF A SOLID BY SUPERDENSE EXCITATION OF ITS ELECTRONIC SUBSYSTEM. Vaisburg, D. I.; Balychev, I. N. (Tomsk Polytechnic Inst., USSR). JETP Lett. (USSR) (Engl. Transl.); 15: No. 9, 380-2(5 May 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 15: No. 9, 537-40(5 May 1972).

Various solids were irradiated by an intense electron pulse so that the average excitation energy density reached W ~ 10^{20} to 10^{22} ev/cm^3. Destruction of the solid (rupture of ionic and covalent thin-plate samples, Lichtenberg figures in thick samples, and swelling or erosion of plastic solids) resulted if the energy density absorbed exceeded W_{des} (= 15×10^{20} eV/cm^3 for Ge and 1.1 to 3×10^{20} eV/cm^3 for alkali metal halides). It was determined that the electric charge, thermal gradient, and defects cannot account for the observed effects, which are probably due to the contracting of the electrons and holes into Frankel condensations with equilibrium density 10^{21} to 10^{22} cm^{-3} and W exceeding the binding energy. (D.L.C.)

55013 CHARGE STATE OF DEFECTS IN GERMANIUM CONVERTED INTO p-TYPE BY 1 MeV ELECTRONS. Werner, Zbigniew; Rzewuski, Henryk; Suski, Jan. (Inst. of Nuclear Research, Swierk, Poland). Nukleonika; 17: No. 1-2, 1-9(1972).

The concentration and Hall mobility changes in the reversible isochronal annealing process observed between 100 and 140°K in germanium converted into p-type by 1-MeV electron irradiation at 140°K were measured. It was found that the charge state of minority carrier traps created by 1-MeV electrons oscillates between 0 and +1 for traps populated and ionized, respectively. (auth)

55014 DETERMINATION OF IMPLANTATION PROFILES IN SOLIDS BY SECONDARY-ION MASS SPECTROMETRY. Maul, J.; Schulz, F.; Wittmaack, K. (Gesellschaft fuer Strahlen- und Umweltforschung mbH, Nuremberg). Phys. Lett.; 41A: No. 2, 177-8(11 Sep 1972).

Secondary ion mass spectrometry was applied to a determination of the profile of 22-keV boron ions implanted in amorphous silicon. A Gaussian range distribution is observed with a projected range of 840 Å and a standard deviation of 340 Å. (auth)

55015 THERMALLY STIMULATED CURRENTS AND THERMOLUMINESCENCE OF PARAMAGNETIC CENTERS IN HEXAGONAL BORON NITRIDE. Katzir, A. (Soreq Nuclear Research Centre, Yavne, Israel); Suss, J. T.; Halperin, A. Phys. Lett.; 41A: No. 2, 117-18(11 Sep 1972).

Isochronal annealing of paramagnetic centers in BN showed a correlation between EPR, thermally stimulated currents, and thermoluminescence measurements. It was found that the one- and three-boron centers give rise to two types of traps with activation energies of (0.6 ± 0.1) eV and (1.0 ± 01) eV, respectively. (auth)

55016 EFFECTIVE CROSS SECTIONS OF PROTON AND ALPHA PARTICLE TRACKS IN IONIC CRYSTALS. Vaisburd, D. I.; Vorob'ev, A. A.; Melikyan, L. A. This paper was summarized in At. Energ. (USSR); 30: No. 6, 538(Jun 1971) as paper No. 502/5971. (In Russian).

Full copy of this paper is held by TIC.

Effective transverse sizes of proton (1 to 6 MeV) and alpha-particle (4 to 25 MeV) tracks in NaCl monocrystals were determined from the transformation kinetics of electron color centers. The F_2-center concentration follows the law $n = N[1 - \exp(-\Omega\nu)]$, where N is the saturation level of regenerated centers, Ω is effective track volume, and ν is instantaneous track concentration. The width of the radial distribution of energy transfer per unit volume is 4.5×10^{19} eV/cm^3. The radius of a proton track is 74 ± 5 Å, while an alpha-particle track is 155 ± 15 Å. (D.L.C.)

55017 INVESTIGATION OF STATIC ELECTRON IRRADIATION EFFECTS IN BULK Si AND THIN Si FILMS AT ENERGIES FAR BELOW THRESHOLD. Norris, C. B. (Sandia Labs., Albuquerque, N. Mex.). J. Appl. Phys.; 43: No. 10, 4060-7(Oct 1972).

A study was made of the defect production in Si at electron-irradiation energies far below the theoretically predicted 170-keV bulk-damage threshold. In contrast to published results, the experiments show no permanent resistance changes in bulk samples at fluences as high as 2×10^{18} 20-keV e/cm^2 (78°K). Furthermore, fundamental damage studies using EPR techniques and optical spectroscopy confirm that fewer than 10^{-4} to 10^{-5} atomic displacements occur per 20-keV electron. These results disagree with previous studies of irradiation-induced resistance changes in bulk samples and epitaxial films from which it was indirectly determined that subthreshold atomic displacements appear following ionization of a Si K-shell electron. However, large resistance decreases do occur in p-type Si/spinel films at fluences $\gtrsim 10^{15}$ 20-keV e/cm^2 (300°K) that appear similar to anomalous results in the literature. But the energy and fluence dependences of the resistance change in the experiments are correctly predicted by theory for an irradiation-induced charge accumulation layer localized within <500 Å of the irradiated Si surface. The results do not indicate the presence of a bulk-damage mechanism. The K-shell hypothesis is clearly ruled out since the resistance effect remains at energies well below the K-shell ionization potential. A corresponding irradiation effect in n-type Si/spinel films is not found, which is consistent with the fact that nearly all the previously reported subthreshold irradiation effects have appeared in p-type Si. Results clarify some puzzling aspects of previously reported low-energy electron irradiation effects in Si and also indicate that the unambiguous determination of defect introduction or existing defect modification by subthreshold irradiation of semiconductors requires fundamental techniques that can be rendered immune to surface phenomena. (auth)

55018 THEORETICAL MODEL FOR X-RAY EMISSION AND ABSORPTION, BOND BREAKING, AND POINT-DEFECT PRODUCTION IN SiO_2. Ruffa, A. R. (Naval Research Lab., Washington, D. C.). J. Appl. Phys.; 43: No. 10, 4263-5(Oct 1972).

An analysis of the effects of radiation damage in SiO_2 is made within the framework of the valence-bond approximation. According to this model, the less energetic and intense satellite in the oxygen K_α emission spectrum results from the breaking of an Si–O bond. The calculated energy separation and intensity ratio of the two lines agree favorably with experiment. The model further indicates that the end result of the radiative processes is the production of transient paramagnetic point defects in the pure material and permanent defects in the impure material. In this sense, this model goes a step further than the usual molecular orbital or band pictures in that it provides a different description of the ionized and un-ionized states. Some implications of these conclusions are discussed in detail. (auth)

55019 X-RAY TOPOGRAPHIC DETERMINATION OF THE ABSENCE OF LATERAL STRAINS IN ION-IMPLANTED SILICON.

Tu, K. N.; Chaudhari, P.; Lal, K.; Crowder, B. L.; Tan, S. I. (IBM Watson Research Center, Yorktown Heights, N. Y.). J. Appl. Phys.; 43: No. 10, 4262-3(Oct 1972).

The lattice-to-amorphous transformation of Si caused by implantation of silicon ions results in volumetric expansion. The expansion is primarily in a direction normal to the substrate surface. This is inferred from x-ray topographic analysis where no evidence of plastic flow in the region bounding the implanted volume was detected. By measuring the unidirectional expansion, the average density of the amorphous Si layer is found to be 3.8 to 5.6% smaller than that of crystalline Si. (auth)

55020 X-RAY AND DIELECTRIC STUDIES OF IRRADIATED PEROVSKITE TYPE COMPOUNDS. Solovev, S. P.; Kuzmin, I. I.; Zakurkin, V. V.; Dudarev, V. Ya. J. Phys. (Paris); 33: No. 4, 443-5(Apr 1972).

Polycrystalline samples of $BaTiO_3$, $SrTiO_3$, $PbTiO_3$, $NaNbO_3$, and $PbZrO_3$ were irradiated with fast electrons and gamma radiation from ^{60}Co. Identical reversible changes in their dielectric constants were observed. Fast-neutron in-pile irradiation (up to integrated fluxes of 10^{20} cm^{-2}) of $PbTiO_3$ resulted in crystal structure transformations into an amorphous state, followed by the formation of a $\beta-PbO_2$ phase. The variation of the lattice parameters are similar to those of $BaTiO_3$ and $PbZrO_3$. (France)

Physical Properties

Refer also to abstracts 52937 and 53564.

55021 MAGNETORESISTANCE OF NEODYMIUM METAL. Nagasawa, H. (Tokyo Univ. of Education). Phys. Lett.; 41A: No. 1, 39-40(28 Aug 1972).

The transverse and longitudinal magnetoresistance on the polycrystalline dhcp Nd was measured at 1.38, 4.2, 13.96, and 20.4°K with applied fields up to 20 kOe. (auth)

55022 HIGH-TEMPERATURE VACUUM EVAPORATION OF ZIRCONIUM CARBIDE + TUNGSTEN COMPOUNDS FROM AN OPEN SURFACE AND THROUGH A TUNGSTEN COATING. Nikol'skaya, T. A.; Vil'k, Yu. N. Sov. Phys.-Tech. Phys. (Engl. Transl.); 17: No. 2, 341-3(Aug 1972).

Translated from Zh. Tekh. Fiz.; 42: No. 2, 429-32(Feb 1972).

The evaporation of ZrC + W compounds (ZrC + 10 wt % W and ZrC + 30 wt % W) from an open surface into a vacuum, and the evaporation of ZrC + 30% W with a tungsten coating at 2600 to 2970°K are investigated. The addition of tungsten reduces the ZrC evaporation by 50%; a tungsten coating reduces it by a further factor of 4 to 4.5. The protection provided by the coating is reduced by keeping the specimen at the same temperature, and this effect increases with increasing temperature. (auth)

55023 ADSORPTION AND DISSOCIATION OF CO ON TUNGSTEN SURFACE STUDIED BY FIELD-EMISSION MICROSCOPY. Senzaki, Kiyoshi; Kawasaki, Koji (Electrotechnical Lab., Tokyo). Jap. J. Appl. Phys.; 11: No. 9, 1363-71(Sep 1972).

The adsorption and desorption of CO for tungsten were studied by a field-emission microscope with a steady-state or pulsed field to make clear the location dependency of binding states of CO adsorbed on tungsten surface, i.e., one weakly held α state and three more strongly held β states which are distinguished by flash desorption measurements. CO in the α state is found on all the planes of tungsten, whereas the β states depend on the surface structure. From observations above 600°C, there seems to be some possibility of dissociation of CO on hot tungsten. (auth)

55024 PHOTOELECTRON SPECTROSCOPIC MEASUREMENTS OF CORE LEVEL BINDING ENERGIES OF YTTRIUM, LANTHANUM, AND CERIUM. Nagakura, Ichiro; Ishii, Takehiko; Sagawa, Takasi (Tohoku Univ., Sendai). J. Phys. Soc. Jap.; 33: No. 3, 754-60(Sep 1972).

X-ray photoelectron spectra were measured on in-situ evaporated films of yttrium, lanthanum, and cerium by the use of an electron-energy analyzer of the parallel-plate-electrode type. The binding energies of electronic core levels were determined. Results are compared with the values cited in typical x-ray atomic energy tables. The binding energies of the $M_4(3d_{\frac{5}{2}})$ and $M_5(3d_{\frac{3}{2}})$ levels of lanthanum and cerium as well as the $N_2(4p_{\frac{1}{2}})$ and $N_3(4p_{\frac{3}{2}})$ levels of lanthanum are all found to be split into two components. Possible origins of the splitting are discussed, although no definite conclusion is drawn. (auth)

55025 PROPERTIES AND INTERACTIONS OF LANTHANIDES: INTERACTIONS WITH EXTERNAL FIELDS. Saxena, K. M. S.; Fraga, S. (Univ. of Alberta, Edmonton). Can. J. Phys.; 50: No. 12, 1411-4(15 Jun 1972).

The values of the diamagnetic susceptibilities and nuclear magnetic shielding constants, calculated from numerical Hartree–Fock functions, are reported for the neutral atoms and the first three positive ions of the lanthanides. (auth)

55026 NEW MAGNETOELASTIC INTERACTION. Liu, S. H. (Univ. of Copenhagen). Phys. Rev. Lett.; 29: No. 12, 793-5(18 Sep 1972).

A mechanism is proposed for the mixing of acoustic magnons and optic phonons propagating along the c axis in terbium observed at 79°K. The interaction involves an intermediate state in which an electron–hole pair is excited virtually by the phonon and subsequently recombines into a magnon. This interaction becomes possible when the spin–orbit coupling is taken into account, and it also explains the mixing of optic magnons and acoustic phonons as seen in terbium at 200°K and dysprosium at 4.7°K. (auth)

55027 INVESTIGATION OF THE THERMAL CONDUCTIVITY, ELECTRICAL RESISTIVITY, AND THERMOELECTRIC POWER OF THORIUM NITRIDE–URANIUM NITRIDE ALLOYS. Weaver, Samuel Cavin. Knoxville, Tenn.; Univ. of Tennessee (1972). 217p. University Microfilms Order No. 72-21,368.

Thesis.

Measurements were made on ThN, (Th–2% U)N, (Th–5% U)N, and UN. Results indicated that ThN behaves very nearly as a pure metal in its transport properties. Thermal conductivities (λ) were high, electrical resistivities (ρ) were low, and thermoelectric power (S) measurements were nearly zero. UN, which is antiferromagnetic below 50°K and has a lower λ, a much higher ρ, and a large positive S. The λ of ThN is much higher than nuclear fuels being considered for LMFBR. At reactor operating temperatures, λ for ThN is approximately 20 times that of UO_2. Even when alloyed with UN, ThN retained a λ greater than any other ceramic fuel being considered. Calculations show the fuel potential of ThN alloyed with UN or PuN as fuels in proposed reactor concepts. The ρ measurements showed ThN and the (Th–U)N alloys to have a linear dependence with temperature above about 100°K. Below 100°K, the slope changed to near zero at 0°K. Small additions of UN to ThN of 2 and 5% caused a very large increase in ρ. This probably resulted because the antiferromagnetic UN exhibits a large ρ. In addition to changing the residual resistivity at 4.2°K, $d\rho/dT$ was reduced by alloying. The S of ThN is very small. However, alloying with UN, which has a large value for S, caused a significant change in the S of (Th–U)N alloys. The data treatment permitted a separation of λ into a lattice conductivity, λ_L, and an electronic contribution to the thermal conductivity, λ_e, and both contributions were significant over the temperature range studied. The separation allowed a prediction of λ at temperatures greatly exceeding the range of actual experimental measurements. The Lorentz function was calculated and found to be very near the Sommerfeld value at temperatures of 300°K and above. In order to make high-quality samples, a zone-melting technique was developed that converted the metal directly into the nitride at a state ~100 times as fast as conventional techniques. The fabricated samples were nearly 100% dense with very large grains of ~0.3 cm dia. (TSS) (Diss. Abstr. Int., B)

55028 1971 DIGESTS OF THE INTERMAG CONFERENCE, DENVER, COLORADO, APRIL 13–16, 1971. 71 C 12-MAG. New York; Institute of Electrical and Electronics Engineers, Inc. (1971). 187p. $4.00. (CONF-710446).

The 214 papers were presented in 33 sessions dealing with: ferrites, domain devices and techniques, magneto-optics, charge transfer devices and magnetic bubbles, recording media and techniques, cobalt rare earth magnets, instruments, video recording, bubble materials, memory devices and systems, electromechanical devices, storage hierarchies, magnetic recording theory, low-coercivity materials, permanent magnets, ferroresonant regulators and power conditioning, bulk storage, garnets, hard materials, recording heads, magnetization processes, plated-wire memory, microwave materials and resonance, and microwave integrated circuits. (D.L.C.)

55029 PARAMAGNETIC RELAXATION INITIATED BY FLUX JUMPING. Griffiths, D. J. (Oregon State Univ., Corvallis). Phys. Lett.; 41A: No. 1, 21-2(28 Aug 1972).

Controlled flux jumping of type-II superconductors was used to produce nonequilibrium spin distributions in Ce^{3+} 1 at.%: CaF_2. The subsequent return to thermal equilibrium was examined by monitoring the magnetic-optical Faraday effect of the cerium ions. (auth)

55030 MAGNETIC SUSCEPTIBILITIES OF NONSTOCHIOMETRIC CERIUM OXIDES. Ariya, S. M.; Balashova, E. P. Vestn. Leningrad. Univ., No. 22, Fiz., Khim.; No. 4, 151-2(Nov 1971). (In Russian).

Magnetic susceptibilities of some nonstoichiometric cerium oxides were measured. Magnetic moments calculated for a Ce(III) atom approach the value of $\mu = \sqrt{J(J+1)} = 2.56\ \mu_B$. (auth)

55031 VIBRATIONAL SPECTRA AND STRUCTURES OF RARE EARTH OXIDES IN THE A MODIFICATION. Denning, J. H.; Ross, S. D. (Chelsea Coll. of Science and Tech., London). J. Phys., C (London); 5: No. 11, 1123-33(12 Jun 1972).

Crystallographic studies of La_2O_3 and the oxides isostructural with it failed to decide between the noncentrosymmetric space group D_3^1(P321) and the centrosymmetric space group D_{3d}^1($P\bar{3}m$ 1) for their structure. The infrared and Raman spectra of La_2O_3 and Nd_2O_3 were obtained, and the absence of coincidences between the spectra unequivocally favors the centrosymmetric space group. The vibrational spectra were analyzed using the Wilson FG matrix method and force constants for metal–oxygen and oxygen–oxygen interactions derived, assuming a quadratic central force field. (auth)

55032 SPECTROSCOPY OF RARE EARTH OXIDE SYSTEMS. I. FAR INFRARED SPECTRA OF THE RARE EARTH SESQUIOXIDES, CERIUM DIOXIDE, AND NONSTOICHIOMETRIC PRASEODYMIUM AND TERBIUM OXIDES. Bloor, D.; Dean, J. R. (Queen Mary Coll., London). J. Phys., C (London); 5: No. 11, 1237-52(12 Jun 1972).

The far-infrared spectra of the rare earth sesquioxides, cerium dioxide, and nonstoichiometric praseodymium and terbium oxides were observed over the range 10 to 250 cm^{-1} at liquid helium temperatures. Absorptions due to the excitation of phonons and low-lying electronic states of the rare earth ions occur in this region. The long-wavelength phonons in the sesquioxides involve motions of the rare-earth ions in an effectively rigid oxygen lattice. To a first approximation, the absorptions can be described using the rare-earth-ion site symmetries. This, together with observations of the linewidths and frequencies in mixed crystals, suggests that these phonons have the character of a local resonant mode. Strong interactions between these phonons and the electronic excitations of the rare-earth ions were observed. In general, the observed electronic energies agree with those obtained by less direct methods; however, in a few cases significant differences were found. The spectra of the other oxides indicate the presence of complex or mixed phases. (auth)

55033 MAGNETIC STRUCTURE OF $HoAu_2$. Atoji, Masao. (Argonne National Lab., Ill.). J. Chem. Phys.; 57: No. 6, 2402-6(15 Sep 1972).

Neutron-powder diffraction measurements reveal that $HoAu_2$ (the tetragonal body-centered CaC_2-type structure) becomes an antiferromagnet below $T_N(\alpha) = 9.2°K$ with the onset of an incommensurate moment alignment (α) having a transverse wave modulation. The α magnetization wave with the wavelength, 6.373 Å = 1.229 a, propagates along the a axis and is polarized approximately in the direction of the b axis, all in the face-centered lattice description. At $T_N(\beta) = 7.8°K$, a commensurate transverse magnetization wave (β) starts to grow. The β wave with the wavelength equal to the a spacing propagates along the a or b axis and is polarized in the direction of the c axis. The composite configuration of the α and β transverse waves may be described as an antiferromagnetic triangular-fan structure. In cooling, the α wave amplitude reaches rapidly to a maximum value of 6.7 μ_B at 6.3°K, then decreases monotonically, and diminishes near 0°K. The β wave moment follows the Brillouin curve and approaches 6.4 μ_B at 0°K. The composite ordered moment rises to a maximum value of 7.8 μ_B at around 5.5°K and declines toward 6.4 μ_B at 0°K. These moment values which are considerably smaller than 10 μ_B of the free Ho^{3+} ion indicate a strong crystal field effect. The phenomenon that the maximum composite moment occurs near the midpoint of the ordered phase is due likely to a strongly anisotropic, competing interaction between the RKKY exchange coupling and the crystal field effect. (auth)

55034 MAGNETIC STRUCTURE OF $ErAu_2$. Atoji, Masao (Argonne National Lab., Ill.). J. Chem. Phys.; 57: No. 6, 2407-9(15 Sep 1972).

The magnetic properties of $ErAu_2$ having the tetragonal body-centered CaC_2-type structure were investigated at temperatures between 297 and 1.8°K by neutron diffraction experiments on powdered specimens. The onset of an incommensurate, transverse wave moment alignment (the α structure) occurs at 6.7°K. The α magnetization wave propagates along the a axis and is polarized in the b direction, all in the face-centered description. The α wavelength is 6.443 Å = 1.248 a and is temperature independent. At 4.0°K, a commensurate antiferromagnetic moment wave (the β structure) appears with the propagation direction parallel to the a axis. The β wavelength is equal to the a spacing. As regards the β moment components, the x || a component is slightly larger than the y || b component and the z || c component is undetectably small. The composite configuration of the α and β waves delineates a distorted-fan modulation. In cooling, the α amplitude develops to 6.7 μ_B at 4°K, then decreases to 5.9 μ_B near 3°K, and retains 5.9 μ_B at $3 > T > 0°K$. The β wave moments approximate the Brillouin magnetization with the extrapolated moments of 3.2 and 2.7 μ_B at 0°K for the x and y components, respectively. The maximum composite moment is 9.2 μ_B at 0°K, while the ordered moment of the free Er^{3+} ions is 9.0 μ_B. (auth)

55035 MAGNETIC AND CRYSTAL STRUCTURES OF ErC_2 AT 297 – 2°K. Atoji, Masao (Argonne National Lab., Ill.). J. Chem. Phys.; 57: No. 6, 2410-13(15 Sep 1972).

Neutron-powder diffraction measurements show that the tetragonal body-centered ErC_2 becomes antiferromagnetic below 19 ± 2°K. The moment alignment is governed by several narrowly dispersed, incommensurate transverse magnetization waves. The major modulation waves propagate along the a axis and are polarized in the b axis direction. The magnetization wavelengths are 5.78, 5.4, 6.7, and 7.1 Å, and the amplitudes are respectively 6.55, 2.2, 2.1, and 1.6 μ_B at 4.2°K. The ferromagnetic alignment in the plane perpendicular to a is slightly altered by several long-periodicity modulations propagating along the b and c axes. A commensurate, antiferromagnetic wave also participates in the moment alignment below 10 ± 3°K. The commensurate wave is represented by setting the wavelength equal to the a spacing in the incommensurate wave mode. The commensurate moment is 2.5 μ_B at 4.2°K. The root-mean-square value of all the moment amplitudes is 7.8 μ_B at 4.2°K and increases to 7.9 μ_B at 2°K. These features are likely caused by a strong perturbation between the RKKY coupling and the crystal-field effect. The proposed structure is by no means unique, although an exhaustive search for other probable models was fruitless. The crystal structure is characterized by the C—C bonding distance of 1.288 ± 0.006 Å and the Er–C distances of 2.403 ± 0.003 and 2.640 ± 0.001 Å. These distances are indicative of a large 5d–π_g2p contribution in the conduction-band wavefunction. (auth)

55036 ESR STUDY OF THE PYROLYSIS OF HYDROGEN ON TUNGSTEN. Cochran, Edward L.; Bowers, Vernon A.; Adrian, Frank J. (Johns Hopkins Univ., Silver Spring, Md.). J. Chem. Phys.; 57: No. 6, 2384-8(15 Sep 1972).

Electron spin resonance (ESR) techniques were adapted to the study of the atomization of hydrogen occurring on the surface of heated filaments. The method involves heating an axial metal filament in a circular cavity to temperatures of 1000 to 2000°K and measuring the steady-state atom concentration produced in the gas. Heating is accomplished by dc current pulsed at 6000 pulses/sec with a 15% duty cycle. Under these conditions, the sample space is free a relatively high proportion of the time from current-induced field inhomogeneities. The sensitivity and spectral line shapes observed compare favorably with those observed in control experiments in the same cavity in the absence of the heated filament. The atomization of hydrogen on tungsten filaments can be conveniently studied by ESR at hydrogen pressures between 0.1 and 100 torr; thus, this method complements previously developed techniques that are most useful at lower pressures (10^{-6} to 10^{-2} torr). The observed pressure and temperature dependences of the H atom concentration are interpreted in terms of a mechanism involving the production of hydrogen atoms on the filament, their diffusion into the gas, and recombination on the cavity wall. The surface reaction appears to be complex, changing character at an H_2 pressure somewhere around 0.5 torr. Extrapolation of the ESR data to very low H_2 pressures yields results consistent with previous low pressure studies. At higher H_2 pressures the rate of H atom production decreases due to surface saturation effects. (auth)

55037 INHOMOGENEOUS MAGNETIC SYSTEMS. Neumann, L. (Siemens AG, Erlangen, Ger.). Z. Phys.; 253: No. 5, 404-14(1972). (In German).

Within the molecular-field approximation the Gibbs free energy G is calculated for a system with inhomogeneous distribution of magnetic particles. Some properties of such a system derivable from G are compared with magnetic and calorimetric measurements on $Ce_{1-x}Gd_xRu_2$ alloys. (auth)

55038 ATOMIC POSITIONS IN THORIUM SILICATE: AN X-RAY-DIFFRACTION STUDY. Sinha, Devendra Prasad (Patna Univ., India); Prasad, Rameshwar. Indian J. Phys.; 45: No. 9, 435-7(Sep 1971).

The structural study of thorite (thorium silicate) was extended to the powder method using the Hull–Davey chart. The best agreement of observed and calculated intensities was obtained for the tetragonal system. The space group was found to be D_{4h}^{19}–$I4_1/amd$. The bond distances are: Th–4O, 2.51 Å; Th–4O, 2.45 Å; and Si–4O, 1.56 Å. (D.L.C.)

55039 STABILITY OF A TRANSVERSE-WAVE MAGNETIC STRUCTURE AT 1.3 K. Gignoux, D.; Lemaire, R.; Paccard, D. (Laboratoire de Magnetisme, Grenoble, France). Phys. Lett.; 41A: No. 2, 187-8(11 Sep 1972).

Some $TbN_{1-x}Cu_x$ exhibit sinusoidal wave magnetic structures between 1.3°K and T_N. When the crystal-field splitting is pre-

protected by an active charged-particle shield for effective shielding of these detectors in the primary cosmic-ray environment. Data showing the pulse-height spectra of the environmental gamma radiation as measured at 5.3 and 3.8 g/cm^2 residual atmosphere with an unshielded diode detector is also presented. (auth)

54965 (ORNL-TM-3871(Rev.)) SDT5. STAINLESS-STEEL BROOMSTICK EXPERIMENT: AN EXPERIMENTAL CHECK OF NEUTRON TOTAL CROSS SECTIONS. Maerker, R. E. Oak Ridge National Lab., Tenn.). Sep 1972. Contract W-7405-eng-26. 25p. (ENDF-170(Rev.)). Dep. NTIS.

The experimental and calculational details for a CSEWG integral data testing shielding experiment are presented. The experiment was designed to test a given set of neutron total cross sections for a type-310 stainless steel in the range 1.2 to 11 MeV. Separation of neutron- and gamma-induced pulses was made by a modified Forte circuit. The unfolding of the pulse-height distributions was accomplished using the FERDoR code. (M.H.R.)

54966 SPATIAL, ANGULAR, AND ENERGY DISTRIBUTION OF FAST NEUTRONS BEHIND TRIPLE LAYER BARRIERS. Elagin, V. B.; Pekarskii, G. Sh. At. Energ. (USSR); 33: No. 1, 590-1(Jul 1972). (In Russian).

The spatial, energy and angular distributions of fast neutrons from a unidirectional, point source beyond a composite three-layer system of Fe/plastic/Fe and W/Al_2O_3/W were studied as functions of the thickness of the separate layers entering into the composite. The Monte Carlo method was employed with a computer in calculations for 2.5- and 14-MeV neutrons and neutrons from a Po–Be source. (K.S.W.)

54967 CREW RADIATION DOSE FROM A HIGH-IMPULSE GAS-CORE NUCLEAR ROCKET PLUME. Masser, Charles C. (Lewis Research Center, Cleveland). J. Spacecraft Rockets; 9: No. 8, 597-601(Aug 1972).

Analytical calculations are performed to determine the radiation dose rate and total dose to the crew of a gas-core nuclear rocket from the fission fragments located throughout the plume volume. The mission chosen is a manned courier trip to the planet Mars. Four round trip times were picked in which the system was optimized so the initial vehicle mass in Earth orbit was minimized for each trip time. They are 80, 100, 150, and 200 days. For the most probable fission-fragment retention time in the reactor of 100 sec, the unshielded radiation dose to a crew located 100 m from the nozzle exit varies from 170 Rem for the 80-day round trip to 38 Rem for the 200 day round trip. For the 80-day round trip the crew must be protected from the radiation dose. Five centimeters of lead shielding would reduce the radiation dose by two orders of magnitude, thereby protecting the crew. (auth)

PHYSICS (SOLID-STATE)

Radiation Effects

Refer also to abstracts 52985, 53229, 53314, and 54874.

54968 (AD–737312) RESEARCH ON THE PHYSICS OF TRANSIENT RADIATION EFFECTS. Final Report, February 2, 1968–October 31, 1971. Azarewicz, Joseph L.; Berger, Robert A.; Cesena, Rodolfo A.; Colwell, Joseph F.; Denson, Raymond (Gulf Radiation Technology, San Diego, Calif.). Feb 1972. Contract DAAG39-68-C-0060. 140p. (GULF-RT-A-10870; HDI-60-3). NTIS.

CHERENKOV RADIATION—use to measure transient free carrier absorption in insulators, feasibility of
ELECTRONS—effects on silicon, (E/T)
—effects on gallium arsenide, (E)
—effects on electric conductivity of naphthalene, (E/T)
GALLIUM ARSENIDES—radiation damage in, electron, (E)
GAMMA RADIATION—effects on electric properties of polystyrene capacitors with metal electrodes, (E)
NAPHTHALENE—radioinduced electric conductivity of, electron, (E/T)
NEUTRONS—effects on silicon, (E/T)
SILICON—radiation damage in, neutron and electron, (E/T)
STYRENE POLYMERS—radioinduced carriers in capacitors of, γ, (E)

54969 (AECL–4130) COMPUTER PROGRAM TO CALCULATE DAMAGE DISTRIBUTIONS IN ION-BOMBARDED TARGETS. Caillibot, P. F.; Hunt, C. E. L. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). May 1972. 52p. Dep. NTIS (U. S. Sales Only). AECL $1.50.

Simulation of fission damage by means of ion bombardment eliminates induced radioactivity and reduces experimental time by several orders of magnitude. However, the conditions under which such bombardments are to be done must be carefully determined. The mathematical model developed by Lindhard et al., based on a Thomas–Fermi potential between the atoms, was used. The required calculations are time-consuming; therefore, a computer program, IONR, was written. It calculates the damage profile produced in a target by any projectile. For a range of energies it will calculate the relative bombardment times to approximate a homogeneous damage profile up to the maximum penetration depth. Results are produced both as graphs and tables. An example is presented for argon bombardment of zirconium. (auth)

54970 (CEA-CONF–1890) COMPUTER SIMULATION IN RADIATION DAMAGE STUDIES. Torrens, Ian M. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1972. 32p. (CONF-720423–4). Dep. NTIS (U. S. Sales Only).

From first European conference on computational physics; Geneva, Switzerland (10 Apr 1972).

The application of atomistic computer simulation to problems involving radiation damage and lattice defects in crystalline solids is discussed. The different topics include static defect configurational simulations, molecular dynamics of thermal motion, low-energy atomic collision events, high-energy atomic displacement cascades, and the thermal annealing of concentrations of defects in a lattice region. The methods described are criticized from the point of view of the assumed physical models, and their capabilities and limitations are indicated. Emphasis is on techniques used rather than on results obtained. (auth)

54971 (CEA-R–4313) ELECTROLUMINESCENT DIODES FORMATION IN ION IMPLANTED ZINC TELLURIDE. Marine, Jean (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Jun 1972. 101p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

Radiative-recombination mechanisms and minority-carrier injection devices are reviewed, and ion implantation is presented as a doping method in order to achieve electroluminescent diodes in a nonstoichiometric material such as ZnTe. The implanted layer is mainly characterized by: the secondary ion-emission microanalyzer to determine the profile of implanted impurities; the hot probe to determine the conductivity type; the photoluminescence to bring out the levels due to impurities; and the sheet-resistivity measurements. All these measurements show that it is possible to get an n-type layer in a boron- or chlorine-implanted ZnTe. For the diodes achieved, current–voltage characteristic and junction capacitance in reverse-bias measurements show that they were p–i–n type. Two assumptions are suggested to explain the presence of an intrinsic layer between the implanted region (n-type) and the substrate (p-type). Finally, the electroluminescence of these diodes showed that the presence of oxygen gives a red light emission at 6750 Å and, when the material is oxygen-free, the light emission is green at 5580 Å with a quantum efficiency of 0.6% at 300°K. (auth)

54972 (COO–2119–2) EXPERIMENTS IN HIGH-VOLTAGE ELECTRON MICROSCOPY. Progress Report, October 31, 1972–July 31, 1973. Mitchell, T. E.; Das, G.; Kenik, E.; Sklad, P. (Case Western Reserve Univ., Cleveland, Ohio. Div. of Metallurgy and Materials Science). 1 Aug 1972. Contract AT(11-1)-2119. 23p. Dep. NTIS.

Experiments using high-voltage electron microscopy are described that take advantage of the high-resolution selected-area diffraction (SAD) and in-situ electron-radiation-damage capabilities. SAD experiments show that the error distance is 30 times better at 650 kV than at 100 kV; the error distance increases in proportion to the cube of the Bragg angle as expected and is better than 1000 Å for Bragg plane spacings greater than 0.5 Å. Electron-irradiation damage was observed in copper, stainless steel, nickel, vanadium, graphite, and quartz as a function of time and temperature. In Cu, stainless steel, and Ni, faulted interstitial loops are formed that grow, unfault, and then either glide out of the foil or form a dislocation network with other prismatic loops. Void formation was observed in Cu and stainless steel after long doses at high temperatures, using a prior low-temperature irradiation. Radiation-induced carbide precipitation also occurs in stainless steel. In quartz black spot defects are formed, after which the irradiated area becomes amorphous. (auth)

54973 (FRNC-TH–210) PRODUCTION OF HIGH DEFECT CONCENTRATIONS IN ALKALI HALIDES BY ELECTRON BOMBARDMENT. Herrmann, Friedrich (Lyon Univ. (France)). 1971. 80p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

High-defect densities were produced (10^{19} centers/cm^3) by irradiating alkali-metal halide crystals (KCl, KBr, KI, NaCl, and LiF) with electron beams (10 to 50 keV). Optical absorption measurements were used to determine the color-center density. The growth curve represents the variation in the color-center concentration (or optical density) as a function of the radiation dose (or irradiation time). The value of the exponent in the expression linking the electron path to the primary electron energy was determined. It is shown that it is possible to relate the local increase in concentration to an increase in optical density for a nonuniformly colored crystal. The changes in the absorption bands (F, M, and V) in various substances at different temperatures were compared. The growth rate for F centers decreases uniformly during irradiation. A model was developed explaining this decay; this model can be simulated by computer. Some experiments carried out with LiF enabled an upper limit to be established for the threshold energy for the displacement of a cation (1.64 eV). (France)

54974 (LYCEN–7228) CHANNELING OF LIGHT IONS OF 0.5 TO 2 MeV THROUGH A FEW-HUNDRED ANGSTROM-THICK GOLD CRYSTALS. Poizat, J. C.; Remillieux, J. (Lyon Univ. (France). Institut de Physique Nucleaire). May 1972. 37p. (In French). Dep. NTIS (U. S. Sales Only).

A technique to obtain a few hundred-Å-thick self-supporting gold crystals is described. These crystals were used to perform three channeling experiments with 0.5- to 2-MeV light ions: The wide-angle scattering probability as a function of the distance from the crystal surface was studied for an incident beam of particles in the planar and axial directions. The influence of channeling on the light emission from crystal-excited atomic beams was investigated. A strong channeling effect was found on the probability of transmission of a molecular beam of H_2^+ ions through a thin crystal. (France)

54975 (RT/EL–(72)2) MEASURE OF THE PHOTOVOLTAIC EFFECT IN SILICON DIODES OBTAINED THROUGH IMPLANTATION OF IONS. Russo, M.; Sano, A.; Testa, M. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 22 Feb 1972. 77p. (In Italian). Dep. NTIS (U. S. Sales Only).

Results of a study on the photovoltaic effect in Si diodes obtained by the ion implantation technique are reported. The aim of the work was to weigh the possibility of measurement, on the basis of this effect, of some parameters such as the junction depth, minority-carrier diffusion length, etc. Results show that it is pos-

sible to measure the diffusion length of minority carriers in the bulk, by means of the near-infrared spectral response. To obtain the other parameters, it is necessary to utilize also different kinds of measurements. This study also showed that, in the bulk, in proximity of the junction, there was a damage not attributable to the implantation technique. (auth)

54976 ION IMPLANTATION FACILITY AT ORSAY. Chaumont, J.; Baran-Marzak, M.; Camplan, J.; Meunier, R.; Sarrouy, J. L. (CNRS, Orsay, France). pp 105-11 of International Colloquium on the Application of Vacuum Techniques to the Semiconductor Industry, Electronic, and Microelectronic Components. Paris; Societe Francaise des Ingenieurs et Techniciens du Vide (1971).

From third international symposium on the application of vacuum techniques in semiconductor industry, electronic components, and microelectronics; Versailles, France (13 Sep 1971). See CONF-710932.

The various parts of the ion implantation facility at Orsay are described. Emphasis is given to the ion source and the beam extraction system. Preliminary results obtained for ion implantation are given. (France)

54977 EXPERIMENTAL ARRANGEMENT FOR INVESTIGATION OF SINGLE CRYSTALS BY MEANS OF FAST IONS. Haan, G.; Flagmeyer, R.; Geist, V.; Mende, A.; Lehmann, D. (Karl Marx Univ., Leipzig). Exp. Tech. Phys.; 20: No. 1, 67-80(1972). (In German).

A detailed description is given of a measuring equipment for channeling and blocking experiments with a brief introduction to these effects. The main part of the work is concerned with the description and the physical reasons of special elements such as collimator, beam current measurement, crystal mounting, cooling device, and so on. Results are given of first experimental tests with a tungsten single crystal. (auth)

54978 PHONON SCATTERING BY VANADIUM IONS IN Al_2O_3. de Goer, A. M.; Devismes, N. (CEN, Grenoble, France). J. Phys. Chem. Solids; 33: No. 9, 1785-93(Sep 1972).

Thermal conductivity measurements were made between 1.3 and 150°K on several vanadium-doped Al_2O_3 single crystals, in their as-received state and after γ irradiation. One Ti-doped sample was also measured. The results are well explained by ascribing the resonant phonon scattering observed to transitions between low-lying energy levels of V^{4+} and Ti^{3+} ions. A good fit of the curves was obtained using Callaway's (1959) method. Resonant scattering is described by an additional phonon relaxation time of the form: $[\tau_2^{-1} = D_1(\omega^4/(\omega^2 - \omega_1^2)^2) + (D_2/D_1)\ (\omega^4/(\omega^2 - \omega_2^2)^2]$ where $\hbar\omega_1 = \delta_1$ and $\hbar\omega_2 = \delta_2$ are known, and D_2/D_1 is kept constant for all V-doped specimens. From these quantitative analysis and coupled EPR measurements, it was possible to estimate that only 1% of the total vanadium content was in the V^{4+} valence state in all as-received samples. Hence the great sensitivity of low-temperature thermal conductivity to the presence of ions subjected to a dynamic Jahn–Teller effect is confirmed in the case of these Kramers d^1 ions. (auth)

54979 OBSERVATION OF DISLOCATION LOOPS IN GADOLINIUM THIN SINGLE CRYSTAL. Srivastva, M. M.; Srivastava, O. N. (Banaras Hindu Univ., India). Jap. J. Appl. Phys.; 11: No. 9, 1237-8(Sep 1972).

Dislocation loops were found to form in hcp Gd thin single-crystal films in an electron microscope. Tiny dot-like features developed, turning into dislocation loops which were often hexagonal-shaped. Stacking fault tetrahedra were also observed. These loops and tetrahedra are due to the aggregation of point defects produced by the bombardment. (D.L.C.)

54980 INTERSTITIAL HALOGEN CENTERS IN X-IRRADIATED CsBr. Chowdari, B. V. R.; Itoh, N. (Nagoya Univ., Japan). J. Phys. Chem. Solids; 33: No. 9, 1773-83(Sep 1972).

Interstitial halogen centers in CsBr produced by x-irradiation at 4.2 and 77°K were studied and assignments of several absorption bands associated with these centers were made. The most prominent bands formed by x irradiation at 4.2°K were the F and H bands. Besides the known two σ-polarized absorption bands associated with the H center, another weakly π-polarized band at 1062 nm was found. The next prominent bands formed at 4.2°K were the α and I bands whose peak positions are at 205 and 236 nm, respectively. X-irradiation at 4.2°K also caused an absorption band at 324 nm due to H^1 center. It is shown that the height of H^1 band is proportional to the square of the height of the H band, suggesting that the centers associated with the H^1 band are di-H-centers. Optical and thermal bleaching of the H bands causes the increase in H^1 band. The study of the thermal annealing properties of H^1 band suggests the composite nature of the band. After the H bands were thermally bleached, three absorption bands at 425, 502 and 1060 nm were found to grow whose source might be the interstitial atom associated with an impurity. X-irradiation at 77°K produced the F and V_4 centers, the latter of which has an absorption band at 276 nm. The V_4 center has ⟨100⟩ orientation. The formation and thermal bleaching properties of the H^1 and V_4 bands are compared. (auth)

54981 FAST-NEUTRON-COMPENSATED n-GERMANIUM AS A MODEL OF AMORPHOUS SEMICONDUCTORS. Gadzhiev, A. R.; Ryvkin, S. M.; Shlimak, I. S. (Ioffe Inst. of Physics, and Tech., Leningrad). JETP Lett. (USSR) (Engl. Transl.); 15: No. 10, 428-31(20 May 1972).

Translated from Zh. Eksp. Teor. Fiz.; Pis'ma Red.; 15: No. 10, 605-8(20 May 1972).

A model of an amorphous semiconductor can be produced by producing a random distribution of point defects. This was investigated by irradiating As-doped n-type Ge with fast neutrons, which produce spherical disordered regions of p-type character. The spatial variation of the potential is discussed, and it is shown that the conductivity mechanism should be tunneling over states closer and closer to the Fermi level. Experimental results confirm expectations: the conductivity decreased and acquired an activation character with irradiation dose, Mott's law is satisfied, and the current-voltage characteristic has a S-shape with a considerable negative differential resistance section. (D.L.C.)

54982 TUNNEL ASSISTED HOPPING IN NEUTRON IRRADIATED GALLIUM ARSENIDE. Coates, R.; Mitchell, E. W. J. (Univ. of Reading, Eng.). J. Phys., C (London); 5: No. 10, L113-18(25 May 1972).

The resistivity against dose curve in neutron-irradiated gallium arsenide shows an anomaly. At doses in excess of 10^{17} n cm^{-2} the resistivity decreases with dose. The temperature dependence of resistivity indicates that the mechanism of conduction at high doses is tunnel-assisted hopping. Since the structural studies reveal that even at the highest dose the material remains substantially crystalline, the tunnel-assisted hopping is considered to occur via defect energy levels. (auth)

54983 COMPARISON OF DEFECT CENTRES FORMED IN OXIDES BY EXPLOSIVE SHOCKING AND HIGH-ENERGY RADIATION. Nelson, R. L. (Atomic Energy Research Establishment, Harwell, Eng.); Hartley, D. B. J. Chem. Soc., Dalton Trans.; No. 15, 1596-1603(1972).

ESR and reflectance spectroscopic techniques were used to compare point defects present in MgO, ZnO, and SiO_2 both after explosive shocking and after irradiation with high-energy γ rays, electrons, and neutrons. A high correlation of shocking with irradiation exists in MgO, none in SiO_2, and ZnO occupies an intermediate position. In MgO, explosive shocking induced ionization with trapping of electrons at existing defects and produced vacancy defects (F^+ and F_2^+) by displacement of lattice ions. In SiO_2 none of these effects were present but there is evidence of contamination with carbon as a result of the explosion. This significant difference in behavior to shocking is reflected in the different physical properties of these oxides, but could also be brought about by a suitable choice of explosion conditions. (auth)

54984 LOCALIZED VIBRATIONAL MODES IN GALLIUM ARSENIDE CONTAINING SILICON AND BORON. Thompson, F.; Newman, R. C. (Univ. of Reading, Eng.). J. Phys., C (London); 5: No. 15, 1999-2010(7 Aug 1972).

A comparison was made between the infrared local-mode absorption spectra of boat-grown and pulled crystals of GaAs:Si. The samples were compensated either by electron or neutron irradiation or by copper diffusion. Boron is present in the pulled material and previously unreported lines are assigned as follows: ^{11}B(Ga) (517.0 cm^{-1}), ^{10}B(Ga) (540.2 cm^{-1}), B(Ga)–Si(As) pairs (349.0, 570.9, 596.0, 661.0, and 684.8 cm^{-1}). Two further lines at 762.7 and 796.0 cm^{-1} may be due to interstitial boron atoms produced by the irradiations. It is thought that other lines may be due to the center B(Ga)–Si(As)–Si(Ga). (auth)

54985 DIFFUSION OF POINT DEFECTS TO THE FOIL SURFACE DURING IRRADIATION DAMAGE EXPERIMENTS IN THE HIGH VOLTAGE ELECTRON MICROSCOPE. Foreman, A. J. E. (Atomic Energy Research Establishment, Harwell, Eng.). Radiat. Eff.; 14: No. 3-4, 175-9(Jun 1972).

The high-voltage electron microscope can be used to simultaneously produce and observe irradiation damage structures in thin foils of many materials, including in particular the formation of voidage at elevated temperatures. In such experiments some of the vacancies and interstitial atoms produced in the damage process will be lost by diffusion to the foil surface, so that the results may not be characteristic of the bulk material if the foil is too thin. The steady-state point defect concentrations built up in a thin foil were computed as a function of the foil thickness, defect production rate, and vacancy jump frequency, taking into account the

effect of the mutual recombination of vacancies and interstitial atoms. The coupled diffusion equations for the point defect concentrations were solved numerically for a thin foil, assuming the foil surfaces to be perfect sinks for the point defects, and the results for any material expressed in terms of a single dimensionless parameter. The computations show that for a foil containing few internal sinks, which is the most demanding case, defect concentrations typical of the bulk material can be achieved within an appreciable fraction of a 0.5-μm thick foil, for temperatures up to about one-half the absolute melting temperature. The loss of point defects to the foil surface is shown to be further reduced when the foil contains a high density of internal sinks (e.g. dislocations, voids, precipitate particles) and there is an additional improvement at very high temperatures due to the effect of thermal vacancies. (auth)

54986 COMPUTER CALCULATIONS OF SHEET RESISTANCE OF n- AND p-TYPE IMPLANTATIONS IN SILICON. Smith, B. J.; Stephen, J. (Atomic Energy Research Establishment, Harwell, Eng.). Radiat. Eff.; 14: No. 3-4, 181-4(Jun 1972).

Computer calculations of sheet resistance of ion-implanted layers are described. For Gaussian doping profiles, the sheet resistance depends on the surface concentration and electrical conductivity of the implanted impurity and the standard deviation in the projected ion range. Universal curves were produced from which the sheet resistance of any implanted silicon layer could be derived, provided these parameters were known, and assuming that all the implanted atoms contribute to the electrical conductivity. (auth)

54987 LOCATION OF DIFFUSION-DOPED GOLD ATOMS IN SILICON BY MEANS OF CHANNELING. Iue, N.; Matsunami, N.; Morita, K.; (and others) (Nagoya Univ., Japan). Radiat. Eff.; 14: No. 3-4, 191-3(Jun 1972).

The lattice location of gold atoms diffused into silicon is determined using the channeling of He^+ ions. It is shown that the gold atoms that accumulate at the back surface are located at the hexagonal interstitial sites. (UK)

54988 DECHANNELING OF HEAVY CHARGED PARTICLES IN DIAMOND LATTICES. Morita, K. (Nagoya Univ., Japan). Radiat. Eff.; 14: No. 3-4, 195-202(Jun 1972).

Dechanneling rates of 1.5-MeV protons, deuterons, and helium ions in the (100) axial and (110) planar channels were obtained by analyzing their backscattering energy spectra for the aligned and random directions. The experimental dechanneling rates in the axial channels, inclusive of those in Si, GaP, NaCl, KCl, and KBr single crystals, followed a universal expression for the dechanneling derived using the diffusion model according to Lindhard's theory. Comparing with the theory, the contribution of the electronic collisions to the dechanneling was separated from the contribution of the nuclear collisions. The experimental value of the electronic contribution agreed well with the theoretical value. The experimental value of the nuclear contribution was smaller than the theoretical value by a factor of about 3. The discrepancy between the experimental and the theoretical value of the nuclear contribution is discussed. (auth)

54989 ELECTRICAL RESISTIVITY INCREASE RATES IN Fe–C AND Fe–N SOLID SOLUTIONS DURING NEUTRON IRRADIATION AT 4.5 K. Wagenblast, H.; Schwerer, F. C.; Horak, J. A. (United States Steel Corp., Monroeville, Pa.). Radiat. Eff.; 14: No. 3-4, 203-13(Jun 1972).

A series of α-iron specimens containing carbon and nitrogen in interstitial solid solution were irradiated simultaneously at 4.5°K with fast neutrons to a fluence of 4.7×10^{17} n/cm^2 with E > 0.1 MeV. In-situ electrical resistivity measurements during irradiation showed that the apparent damage rates were dependent on the C or N concentration. In particular, the value of the initial resistivity increment per unit flux (δ), passed through a minimum value at 0.1 at. % N and became larger than the value for pure iron above 0.14 at. % N. The results can be explained qualitatively as interstitial impurity-induced differences in production rates and dispersion of defects or semi-quantitatively as defect-induced deviations from Matthiessen's rule. (auth)

54990 ELECTRON RADIATION DAMAGE NEAR THE THRESHOLD ENERGY IN ALUMINIUM. Wolfenden, A. (Oak Ridge National Lab., Tenn.). Radiat. Eff.; 14: No. 3-4, 225-9(Jun 1972).

Foils of high-purity aluminum, both with and without preinjection of about 10 at. ppM helium, were electron-irradiated in the electron microscope operating at voltages in the range 150 to 200 keV. In the helium-doped aluminum, electron damage in the form of black spots was produced at 150 keV after about 90 min irradiation time. They showed contrast effects characteristic of dislocation loops. No such spotlike damage was observed at 150 keV in the uninjected aluminum for bombardment times over 4 hr. Damage was observed in both pre-injected and uninjected specimens at 175 and 200 keV. Possible mechanisms for subthreshold damage are examined to see which account for the electron damage observed below the accepted threshold of about 170 keV for aluminum. (auth)

54991 PROPERTIES OF PROTON-IRRADIATED DIAMOND. Ananthanarayanan, K. P.; Borer, W. J.; Plendl, H. S.; Gielisse, P. J. (Univ. of Rhode Island, Kingston). Radiat. Eff.; 14: No. 3-4, 245-8(Jun 1972).

Properties of type I diamond were investigated before and after irradiation with 17.0- and 18.3-MeV protons. The optical absorption edge is essentially unchanged. The infrared absorption spectrum shows a strong additional peak at 6.92 μm. A Raman line shift of 4 cm^{-1} indicates an increase of 0.0032 Å in the lattice constant. (auth)

54992 INFLUENCE OF ELECTRON IRRADIATION ON CdS THIN FILMS. Spinulescu, I.; Baltateanu, N. (Univ., Bucharest). Radiat. Eff.; 14: No. 3-4, 257-9(Jun 1972).

The effect of 3-MeV electrons on the crystallographic orientation of cadmium sulfide thin films is studied using electron diffraction. (UK)

54993 FLUX EFFECTS ON DAMAGE IN GaAs AS MEASURED BY THE CHANNELLING OF ^{85}Kr. Grant, W. A.; Baruah, J. N. (Univ. of Salford, Eng.). Radiat. Eff.; 14: No. 3-4, 261-2 (Jun 1972).

The ranges of ions implanted into semiconductors has been extensively studied but little attention has been paid to the dose rate used during the implantation. The influence of dose rate of damage to gallium arsenide single crystals using ^{84}Kr and ^{85}Kr ions is studied. It is concluded that the degree of damage is dependent on the dose rate, the dose dependence of damage will influence the distribution profile of implanted ions, and the dechanneling of heavy ions can be used as a measure of damage. (UK)

54994 PRECIPITATION OF PHOSPHOROUS IN ION IMPLANTED SILICON. Seshan, K.; Washburn, J. Radiat. Eff.; 14: No. 3-4, 267-70(Jun 1972).

Electron microscope observations on phosphorous-ion-implanted ρ-silicon after annealing at 800°C are reported. Heating for $\frac{1}{2}$ hour after implantation of 2×10^{14} ions/cm^2 at 20°C was found to produce dislocation loops and rod-like defects similar to those observed in boron-implanted silicon. It was concluded that the rod-shaped defects were associated with phosphorous precipitation. (auth)

54995 NATURE OF ROD-LIKE DEFECTS OBSERVED IN BORON IRRADIATED SILICON. Madden, P. K.; Davidson, S. M. (Oxford Univ.). Radiat. Eff.; 14: No. 3-4, 271-3(Jun 1972).

The rod-like defects appearing in silicon irradiated with 40-keV B^+ ions were studied by electron microscopy. It is suggested that the rods can best be explained on a model of an elongated faulted dislocation loop, extrinsic in character with an α/k (100) Burgers vector. (UK)

54996 OPTICAL ABSORPTION BANDS OF COLOR CENTERS IN IRRADIATED ANTHRACENE SINGLE CRYSTALS AT LOW TEMPERATURES. Matsuyama, Tomochika; Yamaoka, Hitoshi; Okamura, Seizo (Kyoto Univ., Osaka). Radiat. Eff.; 14: No. 3-4, 275-6(Jun 1972).

Anthracene single crystals were irradiated at 77°K by ^{60}Co gamma rays and the optical absorption spectrum measured. The effect of warming to 399°K on the absorption spectrum is shown. (UK)

54997 SIMILARITIES OF THE IONIZATION EFFECTS AND ANNEALING IN P-TYPE AND CONVERTED N-TYPE Ge IRRADIATED WITH ELECTRONS AT 85°K. Kraitchinskii, A.; Rzewuski, H.; Suski, J.; Werner, Z. (Inst. of Nuclear Research, Warsaw). Radiat. Eff.; 14: No. 3-4, 277-8(Jun 1972).

The annealing behavior of p-type Ge and n-type Ge converted into p-type by electron irradiation is studied. It is concluded that as both types of Ge show the same trapping effects and annealing behavior, the behavior of irradiated Ge can be attributed to some intrinsic type of defect. (UK)

54998 EFFECTS OF GAMMA RADIATION ON PHOTOCURRENT-VOLTAGE CHARACTERISTICS OF CdS FILMS. Kao, K. C.; Sadhu, A. (Univ. of Manitoba, Winnipeg, Can.). Radiat. Eff.; 14: No. 3-4, 279-80(Jun 1972).

Cadmium sulfide films were irradiated with gamma rays from a ^{60}Co source while illuminated with sodium light. The threshold field for the onset of high-field photocurrent saturation increased and the saturation current decreased with increasing radiation dose. It was also found that for a given dose and applied voltage

the change in the photocurrent due to irradiation for CdS films was much greater than for CdS crystals. (UK)

54999 TEMPERATURE DEPENDENCE OF VIBRONIC SPECTRA IN IRRADIATED SILICON. Hare, A. P. G.; Davies, G.; Collins, A. T. (King's Coll., London). J. Phys., C (London): 5: No. 11, 1265-76(12 Jun 1972).

Crucible-grown and high-purity floating-zone silicon specimens were irradiated at room temperature with γ rays. High-resolution cathodoluminescence spectra of the vibronic bands with zero-phonon lines at 0.717, 0.724, 0.790, 0.795, 0.898, and 0.969 eV are given. The widths and energies of these lines, and the intensities of the 0.790, 0.795, and 0.969-eV lines relative to the total intensities of their associated bands, are given in the temperature range 25 to 75°K. These data are discussed in terms of the theory of linear and quadratic electron–phonon coupling in the adiabatic approximation, using Debye spectra of coupled phonons and, for the 0.790, 0.795 and 0.969-eV lines, densities of coupled phonons derived from the emission band shapes. The theory gives a self-consistency between the spectral band shapes and the widths and energies of the zero-phonon lines, but does not satisfactorily fit the temperature dependence of the intensities of the zero-phonon lines. It is not known whether the failure of the theory is due to a Jahn–Teller effect (no absorption at the centers has been detected) or to the coupling by the electron–phonon interaction of electronic states whose energies are not greatly separated compared with the phonon energies involved. (auth)

55000 LIFETIMES OF FAST RECOMBINATION LUMINESCENCE TRANSITIONS IN ALKALI HALIDES. Blair, I. M.; Pooley, D.; Smith, D. (Atomic Energy Research Establishment, Harwell, Eng.). J. Phys., C (London): 5: No. 12, 1537-52(26 Jun 1972).

Measurements were made of the lifetimes of the fast recombination luminescence transitions in alkali metal halides. The luminescence was excited by 2-MeV proton pulses about 2 ns wide and the lifetimes measured by the technique of single photon counting. All alkali metal halides in which fast luminescence occurs were studied at 5 and 77°K. The lifetimes of the major components lie in the range 1 to 4 ns, and in many cases a second component with a lifetime of about 10 to 20 ns is evident. The temperature dependence of luminescence in NaCl, KBr, and KI was measured and compared with the behavior of the slow luminescence in these crystals. A new model for the electronic structure of the excited states involved in recombination luminescence is proposed and compared with the model based on the inert gas molecule. (auth)

55001 VIBRATIONAL AND ELECTRONIC PROPERTIES OF $Co(CN)_6^{3-}$ DOPED IN ALKALI HALIDES. Jain, S. C.; Warrier, A. V. R. (Solid State Physics Lab., Delhi). J. Phys., C (London): 5: No. 12, 1511-18(26 Jun 1972).

The ir spectra of solution-grown crystals of NaCl and KCl doped with $Co(CN)_6^{3-}$ show a multiplet in the Γ_6 stretch frequency region of CN^-. Apparently, the multiplet consists of four components in NaCl and three in KCl. However, a detailed examination of the results shows that the multiplet consists of several components due to different site symmetries in which $Co(CN)_6^{3-}$ is present in the crystal. The most probable symmetries are D_{2h} and D_4. On x irradiation the multiplet characteristic of $Co(CN)_6^{3-}$ decreases in intensity and a new multiplet characteristic of $Co(CN)_5^{3-}$ and a single line characteristic of $Co(CN)_5^{2-}$ appear on the low-energy side. On heating the crystals, irreversible changes in the spectra occur. The spectra consist of many lines, but only the line corresponding to NCO^- could be identified. The electronic spectra of the impurity show seven bands in the wavelength region 600 to 200 nm as compared with only three bands observed in the solution in this region. The bands are interpreted as being due to transitions of the split components of crystal field levels in O_h symmetry. Both peak positions and intensities are consistent with the assignment. (auth)

55002 ANALYSIS OF THE EFFECTS OF ELECTRON DAMAGE ON THE BOUND-TO-BOUND EMISSION INTENSITY OF CADMIUM SULPHIDE. Radford, C. J.; Hagston, W. E.; Bryant, F. J. (Univ. of Hull, Eng.). J. Phys., C (London): 5: No. 12, 1526-36(26 Jun 1972).

Observation of the changes produced in donor–acceptor pair cathodoluminescence emission intensities of as-grown, cadmium-fired, and sulfur-fired cadmium sulfide samples by electron radiation damage allows an estimate to be made of the initial donor concentration present and of the fraction of pairs excited. This analysis also shows that an increase in the donor or acceptor concentration need not necessarily result in an enhancement of the donor–acceptor pair luminescence emission intensity and, under certain circumstances, could lead to a reduction in emission intensity. The observations provide confirmation of this effect. (auth)

55003 SURFACE AND DEPTH DISTRIBUTION DAMAGE OF IONS IN SILICON AS SEEN WITH AN ELECTRON MICROSCOPE. Bertolotti, M.; Sette, D.; Stagni, L.; Vitali, G. (Univ., Rome). Radiat. Eff.; 15: No. 1-2, 31-5(Jul 1972).

The localized damage around ion tracks at the surface of an implanted semiconductor is studied by electron microscopy. It is shown that it is possible to see not only the produced damage but also to follow the depth distribution of the damage under the implanted semiconductor surface. (UK)

55004 PROTON AND FAST NEUTRON DAMAGE STUDIES IN Si AND Ge USING CHANNELING. Marcus, Gail H. (Massachusetts Inst. of Tech., Cambridge); Olson, N. Thomas; Ryan, Jean L. Radiat. Eff.; 15: No. 1-2, 51-6(Jul 1972).

The orientation dependence of the backscattering yield (channeling) of 1.0-MeV protons was used to investigate fast-neutron-induced lattice damage in silicon and germanium single crystals. The measurements were made at room temperature and for protons incident in (110) crystal directions. The reactor irradiations were made, using a fast neutron flux $\phi = 3.3 \times 10^{13}$ n/cm^2-sec (>0.1 MeV) at 60°C, to total exposures (ϕt) between 2.1×10^{17} and 3.4×10^{19} n/cm^2. The per cent of lattice atoms displaced was not linear with neutron exposure. The displacements rose rapidly with exposure initially, then assumed a very slow rise having a dependence on neutron exposure of $(\phi t)^{0.1}$. This appears to be some modification of an exponential saturation mechanism. It agrees qualitatively with a thermal annealing mechanism, which predicts a flux-dependent (i.e., rate of defect introduction dependent) saturation value occurring even for room-temperature irradiations. (auth)

55005 CORRELATED RECOVERY KINETICS. Peak, D.; Brosious, P.; Lee, Y. H.; (and others) (State Univ. of New York, Albany). Radiat. Eff.; 15: No. 1-2, 61-72(Jul 1972).

Diffusion-controlled correlated recovery kinetics are compared for the continuum and discrete lattice treatments. Specific results are given for the simple cubic, face-centered cubic, body-centered cubic, and diamond lattices. It is concluded that samples with anisotropic damage distributions created by irradiation in different crystallographic directions will not exhibit substantial differences in their correlated recovery, but it is argued that for small capture volumes and for the treatment of the early recovery times, the discrete treatment is required. (auth)

55006 NEW EPR SPECTRA IN NEUTRON-IRRADIATED SILICON. Lee, Y. H.; Kim, Y. M.; Corbett, J. W. (State Univ. of New York, Albany). Radiat. Eff.; 15: No. 1-2, 77-84(Jul 1972).

Six new EPR spectra reported are apparently due to intrinsic defects created in the neutron irradiation and, in some cases, annealing of silicon. In addition, a spectrum similar to, but distinct from, that due to the vacancy–phosphorus center is reported. Some tentative defect models are discussed to emphasize the features of the spectra, but more detailed studies are required to establish the identity of the defects giving rise to these spectra. (auth)

55007 THEORY OF FLUX PEAKING EFFECT IN CHANNELING. Kumakhov, M. A. (Moscow State Univ.). Radiat. Eff.; 15: No. 1-2, 85-99(Jul 1972).

The redistribution of the axial- and planar-channeled ion flux was examined. General formulae describing the flux peaking effect were obtained and the main factors on which the effect depends were examined. Backscattering experiments were also analyzed. (auth)

55008 INFLUENCE OF THE INCIDENCE ANGLE ON IRON AND COPPER SURFACE MICROTOPOGRAPHY INDUCED BY ION BOMBARDMENT. Teodorescu, I. A.; Vasiliu, F. (Institutul de Fizica, Atomica, Bucharest). Radiat. Eff.; 15: No. 1-2, 101-13(Jul 1972).

The influence of argon-ion bombardment on iron and copper surface microtropography was studied. Thermal etching revealed a regular microtopography with different oriented grain structure. The surface microrelief is characterized by pyramidal growths at the points where the dislocations intersect the iron surface or by terraced microstructures, depending on the crystallographic orientation on the copper surface. A simple model is introduced for the estimation of the bombardment time necessary for complete erosion of the pyramids on the iron surface. (auth)

55009 ELECTRONIC STOPPING MEASUREMENTS OF CHARGED-PARTICLES IN RADIOPHOTOLUMINESCENT GLASS. Arnold, G. W.; Vook, F. L. (Sandia Labs., Albuquerque, N. Mex.). Radiat. Eff.; 14: No. 3-4, 157-63(Jun 1972).

Measurements were made of the radiophotoluminescence generated in silver-activated phosphate glass by the electronic energy

losses of 200- to 400-keV ions (H^+, He^+, O^+) incident on the glass. Measurements of luminescence growth as a function of energy into electronic processes per unit volume showed a departure from linearity above ~10^{18} keV/cm^3. For lower deposition values, detailed measurements of the integral depth distribution of luminescence intensity were made as material was removed by vibratory polishing. The measured depth distributions compared favorably to the integral depth distributions of electronic energy losses predicted by LSS theory (He^+ and O^+) and to experimental values of thin film losses (H^+). These comparisons indicated that the luminescent centers were formed in the glass close to ($\leq 10^3$ Å) the point of the initial deposition of electronic energy. (auth)

55010 RECOVERY OF ELECTRON-IRRADIATED PLATINUM. 1. STAGE 1 ANNEALING. Dibbert, H. J.; Sonnenberg, K.; Schilling, W.; Dedek, U. (Kernforschungsanlage, Juelich, Ger.). Radiat. Eff.; 15: No. 1-2, 115-27(Jul 1972).

By means of electrical resistivity measurements, the recovery in stage I of electron-irradiated Pt was studied. The effects of irradiation dose, electron energy, radiation doping, and doping with dilute concentrations of Au atoms on the annealing structure were investigated. The recovery in substages I_A, I_B, and I_C was not influenced by irradiation dose and doping agents, in agreement with the model of close Frenkel-pair recombination in these stages. Substage I_E was strongly and substage I_D was moderately modified by variation of radiation dose and the addition of doping agents. This and the equal values of the activation energies confirmed the model of correlated and uncorrelated recovery of free migrating interstitials in these stages. (auth)

55011 RECOVERY OF ELECTRON-IRRADIATED PLATINUM. PART 2. COMPARISON OF STAGE 1 ANNEALING WITH THEORIES FOR 3- AND 1-DIMENSIONAL MIGRATION OF INTERSTITIALS. Sonnenberg, K.; Schilling, W.; Dibbert, H. J.; Mika, K.; Schoeder, K. (Kernforschungsanlage, Juelich, Ger.). Radiat. Eff.; 15: No. 1-2, 129-41(Jul 1972).

The experimental data for the time and dose and energy dependence of the recovery in substage I_D and I_E of electron-irradiated Pt were compared critically with the results of full diffusional treatments of the correlated plus uncorrelated recovery of interstitial–vacancy pairs. Excellent agreement was obtained if in the theoretical treatment three-dimensional migration of interstitials was assumed. In contrast to this, the assumption of one-dimensional interstitial migration (off-line crowdion model) led to serious disagreements with the observed dose dependence of stage I_E. In addition, the strong dependence of the recovery structure in substage I_D and I_E on the energy of the bombarding electrons predicted by the crowdion model was not observed experimentally. (auth)

55012 DESTRUCTION OF A SOLID BY SUPERDENSE EXCITATION OF ITS ELECTRONIC SUBSYSTEM. Vaisburg, D. I.; Balychev, I. N. (Tomsk Polytechnic Inst., USSR). JETP Lett. (USSR) (Engl. Transl.); 15: No. 9, 380-2(5 May 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 15: No. 9, 537-40(5 May 1972).

Various solids were irradiated by an intense electron pulse so that the average excitation energy density reached W ~ 10^{20} to 10^{22} ev/cm^3. Destruction of the solid (rupture of ionic and covalent thin-plate samples, Lichtenberg figures in thick samples, and swelling or erosion of plastic solids) resulted if the energy density absorbed exceeded W_{des} (= 15×10^{20} eV/cm^3 for Ge and 1.1 to 3×10^{20} eV/cm^3 for alkali metal halides). It was determined that the electric charge, thermal gradient, and defects cannot account for the observed effects, which are probably due to the contracting of the electrons and holes into Frankel condensations with equilibrium density 10^{21} to 10^{22} cm^{-3} and W exceeding the binding energy. (D.L.C.)

55013 CHARGE STATE OF DEFECTS IN GERMANIUM CONVERTED INTO p-TYPE BY 1 MeV ELECTRONS. Werner, Zbigniew; Rzewuski, Henryk; Suski, Jan. (Inst. of Nuclear Research, Swierk, Poland). Nukleonika; 17: No. 1-2, 1-9(1972).

The concentration and Hall mobility changes in the reversible isochronal annealing process observed between 100 and 140°K in germanium converted into p-type by 1-MeV electron irradiation at 140°K were measured. It was found that the charge state of minority carrier traps created by 1-MeV electrons oscillates between 0 and +1 for traps populated and ionized, respectively. (auth)

55014 DETERMINATION OF IMPLANTATION PROFILES IN SOLIDS BY SECONDARY-ION MASS SPECTROMETRY. Maul, J.; Schulz, F.; Wittmaack, K. (Gesellschaft fuer Strahlen- und Umweltforschung mbH, Nuremberg). Phys. Lett.; 41A: No. 2, 177-8(11 Sep 1972).

Secondary ion mass spectrometry was applied to a determination of the profile of 22-keV boron ions implanted in amorphous silicon. A Gaussian range distribution is observed with a projected range of 840 Å and a standard deviation of 340 Å. (auth)

55015 THERMALLY STIMULATED CURRENTS AND THERMOLUMINESCENCE OF PARAMAGNETIC CENTERS IN HEXAGONAL BORON NITRIDE. Katzir, A. (Soreq Nuclear Research Centre, Yavne, Israel); Suss, J. T.; Halperin, A. Phys. Lett.; 41A: No. 2, 117-18(11 Sep 1972).

Isochronal annealing of paramagnetic centers in BN showed a correlation between EPR, thermally stimulated currents, and thermoluminescence measurements. It was found that the one- and three-boron centers give rise to two types of traps with activation energies of (0.6 ± 0.1) eV and (1.0 ± 01) eV, respectively. (auth)

55016 EFFECTIVE CROSS SECTIONS OF PROTON AND ALPHA PARTICLE TRACKS IN IONIC CRYSTALS. Vaisburd, D. I.; Vorob'ev, A. A.; Melikyan, L. A. This paper was summarized in At. Energ. (USSR); 30: No. 6, 538(Jun 1971) as paper No. 502/5971. (In Russian).

Full copy of this paper is held by TIC.

Effective transverse sizes of proton (1 to 6 MeV) and alpha-particle (4 to 25 MeV) tracks in NaCl monocrystals were determined from the transformation kinetics of electron color centers. The F_2-center concentration follows the law $n = N[1 - \exp(-\Omega\nu)]$, where N is the saturation level of regenerated centers, Ω is effective track volume, and ν is instantaneous track concentration. The width of the radial distribution of energy transfer per unit volume is 4.5×10^{19} eV/cm^3. The radius of a proton track is 74 ± 5 Å, while an alpha-particle track is 155 ± 15 Å. (D.L.C.)

55017 INVESTIGATION OF STATIC ELECTRON IRRADIATION EFFECTS IN BULK Si AND THIN Si FILMS AT ENERGIES FAR BELOW THRESHOLD. Norris, C. B. (Sandia Labs., Albuquerque, N. Mex.). J. Appl. Phys.; 43: No. 10, 4060-7(Oct 1972).

A study was made of the defect production in Si at electron-irradiation energies far below the theoretically predicted 170-keV bulk-damage threshold. In contrast to published results, the experiments show no permanent resistance changes in bulk samples at fluences as high as 2×10^{18} 20-keV e/cm^2 (78°K). Furthermore, fundamental damage studies using EPR techniques and optical spectroscopy confirm that fewer than 10^{-4} to 10^{-5} atomic displacements occur per 20-keV electron. These results disagree with previous studies of irradiation-induced resistance changes in bulk samples and epitaxial films from which it was indirectly determined that subthreshold atomic displacements appear following ionization of a Si K-shell electron. However, large resistance decreases do occur in p-type Si/spinel films at fluences $\geq 10^{15}$ 20-keV e/cm^2 (300°K) that appear similar to anomalous results in the literature. But the energy and fluence dependences of the resistance change in the experiments are correctly predicted by theory for an irradiation-induced charge accumulation layer localized within <500 Å of the irradiated Si surface. The results do not indicate the presence of a bulk-damage mechanism. The K-shell hypothesis is clearly ruled out since the resistance effect remains at energies well below the K-shell ionization potential. A corresponding irradiation effect in n-type Si/spinel films is not found, which is consistent with the fact that nearly all the previously reported subthreshold irradiation effects have appeared in p-type Si. Results clarify some puzzling aspects of previously reported low-energy electron irradiation effects in Si and also indicate that the unambiguous determination of defect introduction or existing defect modification by subthreshold irradiation of semiconductors requires fundamental techniques that can be rendered immune to surface phenomena. (auth)

55018 THEORETICAL MODEL FOR X-RAY EMISSION AND ABSORPTION, BOND BREAKING, AND POINT-DEFECT PRODUCTION IN SiO_2. Ruffa, A. R. (Naval Research Lab., Washington, D. C.). J. Appl. Phys.; 43: No. 10, 4263-5(Oct 1972).

An analysis of the effects of radiation damage in SiO_2 is made within the framework of the valence-bond approximation. According to this model, the less energetic and intense satellite in the oxygen K_α emission spectrum results from the breaking of an Si–O bond. The calculated energy separation and intensity ratio of the two lines agree favorably with experiment. The model further indicates that the end result of the radiative processes is the production of transient paramagnetic point defects in the pure material and permanent defects in the impure material. In this sense, this model goes a step further than the usual molecular orbital or band pictures in that it provides a different description of the ionized and un-ionized states. Some implications of these conclusions are discussed in detail. (auth)

55019 X-RAY TOPOGRAPHIC DETERMINATION OF THE ABSENCE OF LATERAL STRAINS IN ION-IMPLANTED SILICON.

Tu, K. N.; Chaudhari, P.; Lal, K.; Crowder, B. L.; Tan, S. I. (IBM Watson Research Center, Yorktown Heights, N. Y.). J. Appl. Phys.; 43: No. 10, 4262-3(Oct 1972).

The lattice-to-amorphous transformation of Si caused by implantation of silicon ions results in volumetric expansion. The expansion is primarily in a direction normal to the substrate surface. This is inferred from x-ray topographic analysis where no evidence of plastic flow in the region bounding the implanted volume was detected. By measuring the unidirectional expansion, the average density of the amorphous Si layer is found to be 3.8 to 5.6% smaller than that of crystalline Si. (auth)

55020 X-RAY AND DIELECTRIC STUDIES OF IRRADIATED PEROVSKITE TYPE COMPOUNDS. Solovev, S. P.; Kuzmin, I. I.; Zakurkin, V. V.; Dudarev, V. Ya. J. Phys. (Paris); 33: No. 4, 443-5(Apr 1972).

Polycrystalline samples of $BaTiO_3$, $SrTiO_3$, $PbTiO_3$, $NaNbO_3$, and $PbZrO_3$ were irradiated with fast electrons and gamma radiation from ^{60}Co. Identical reversible changes in their dielectric constants were observed. Fast-neutron in-pile irradiation (up to integrated fluxes of 10^{20} cm^{-2}) of $PbTiO_3$ resulted in crystal structure transformations into an amorphous state, followed by the formation of a $\beta-PbO_2$ phase. The variation of the lattice parameters are similar to those of $BaTiO_3$ and $PbZrO_3$. (France)

Physical Properties

Refer also to abstracts 52937 and 53564.

55021 MAGNETORESISTANCE OF NEODYMIUM METAL. Nagasawa, H. (Tokyo Univ. of Education). Phys. Lett.; 41A: No. 1, 39-40(28 Aug 1972).

The transverse and longitudinal magnetoresistance on the polycrystalline dhcp Nd was measured at 1.38, 4.2, 13.96, and 20.4°K with applied fields up to 20 kOe. (auth)

55022 HIGH-TEMPERATURE VACUUM EVAPORATION OF ZIRCONIUM CARBIDE + TUNGSTEN COMPOUNDS FROM AN OPEN SURFACE AND THROUGH A TUNGSTEN COATING. Nikol'skaya, T. A.; Vil'k, Yu. N. Sov. Phys.-Tech. Phys. (Engl. Transl.); 17: No. 2, 341-3(Aug 1972).

Translated from Zh. Tekh. Fiz.; 42: No. 2, 429-32(Feb 1972).

The evaporation of ZrC + W compounds (ZrC + 10 wt % W and ZrC + 30 wt % W) from an open surface into a vacuum, and the evaporation of ZrC + 30% W with a tungsten coating at 2600 to 2970°K are investigated. The addition of tungsten reduces the ZrC evaporation by 50%; a tungsten coating reduces it by a further factor of 4 to 4.5. The protection provided by the coating is reduced by keeping the specimen at the same temperature, and this effect increases with increasing temperature. (auth)

55023 ADSORPTION AND DISSOCIATION OF CO ON TUNGSTEN SURFACE STUDIED BY FIELD-EMISSION MICROSCOPY. Senzaki, Kiyoshi; Kawasaki, Koji (Electrotechnical Lab., Tokyo). Jap. J. Appl. Phys.; 11: No. 9, 1363-71(Sep 1972).

The adsorption and desorption of CO for tungsten were studied by a field-emission microscope with a steady-state or pulsed field to make clear the location dependency of binding states of CO adsorbed on tungsten surface, i.e., one weakly held α state and three more strongly held β states which are distinguished by flash desorption measurements. CO in the α state is found on all the planes of tungsten, whereas the β states depend on the surface structure. From observations above 600°C, there seems to be some possibility of dissociation of CO on hot tungsten. (auth)

55024 PHOTOELECTRON SPECTROSCOPIC MEASUREMENTS OF CORE LEVEL BINDING ENERGIES OF YTTRIUM, LANTHANUM, AND CERIUM. Nagakura, Ichiro; Ishii, Takehiko; Sagawa, Takasi (Tohoku Univ., Sendai). J. Phys. Soc. Jap.; 33: No. 3, 754-60(Sep 1972).

X-ray photoelectron spectra were measured on in-situ evaporated films of yttrium, lanthanum, and cerium by the use of an electron-energy analyzer of the parallel-plate-electrode type. The binding energies of electronic core levels were determined. Results are compared with the values cited in typical x-ray atomic energy tables. The binding energies of the $M_4(3d_{\frac{3}{2}})$ and $M_5(3d_{\frac{5}{2}})$ levels of lanthanum and cerium as well as the $N_3(4p_{\frac{1}{2}})$ and $N_3(4p_{\frac{3}{2}})$ levels of lanthanum are all found to be split into two components. Possible origins of the splitting are discussed, although no definite conclusion is drawn. (auth)

55025 PROPERTIES AND INTERACTIONS OF LANTHANIDES: INTERACTIONS WITH EXTERNAL FIELDS. Saxena, K. M. S.; Fraga, S. (Univ. of Alberta, Edmonton). Can. J. Phys.; 50: No. 12, 1411-4(15 Jun 1972).

The values of the diamagnetic susceptibilities and nuclear magnetic shielding constants, calculated from numerical Hartree–Fock functions, are reported for the neutral atoms and the first three positive ions of the lanthanides. (auth)

55026 NEW MAGNETOELASTIC INTERACTION. Liu, S. H. (Univ. of Copenhagen). Phys. Rev. Lett.; 29: No. 12, 793-5(18 Sep 1972).

A mechanism is proposed for the mixing of acoustic magnons and optic phonons propagating along the c axis in terbium observed at 79°K. The interaction involves an intermediate state in which an electron–hole pair is excited virtually by the phonon and subsequently recombines into a magnon. This interaction becomes possible when the spin–orbit coupling is taken into account, and it also explains the mixing of optic magnons and acoustic phonons as seen in terbium at 200°K and dysprosium at 4.7°K. (auth)

55027 INVESTIGATION OF THE THERMAL CONDUCTIVITY, ELECTRICAL RESISTIVITY, AND THERMOELECTRIC POWER OF THORIUM NITRIDE–URANIUM NITRIDE ALLOYS. Weaver, Samuel Cavin. Knoxville, Tenn.; Univ. of Tennessee (1972). 217p. University Microfilms Order No. 72-21,368.

Thesis.

Measurements were made on ThN, (Th–2% U)N, (Th–5% U)N, and UN. Results indicated that ThN behaves very nearly as a pure metal in its transport properties. Thermal conductivities (λ) were high, electrical resistivities (ρ) were low, and thermoelectric power (S) measurements were nearly zero. UN, which is antiferromagnetic below 50°K and has a lower λ, a much higher ρ, and a large positive S. The λ of ThN is much higher than nuclear fuels being considered for LMFBR. At reactor operating temperatures, λ for ThN is approximately 20 times that of UO_2. Even when alloyed with UN, ThN retained a λ greater than any other ceramic fuel being considered. Calculations show the fuel potential of ThN alloyed with UN or PuN as fuels in proposed reactor concepts. The ρ measurements showed ThN and the (Th–U)N alloys to have a linear dependence with temperature above about 100°K. Below 100°K, the slope changed to near zero at 0°K. Small additions of UN to ThN of 2 and 5% caused a very large increase in ρ. This probably resulted because the antiferromagnetic UN exhibits a large ρ. In addition to changing the residual resistivity at 4.2°K, $d\rho/dT$ was reduced by alloying. The S of ThN is very small. However, alloying with UN, which has a large value for S, caused a significant change in the S of (Th–U)N alloys. The data treatment permitted a separation of λ into a lattice conductivity, λ_L, and an electronic contribution to the thermal conductivity, λ_e, and both contributions were significant over the temperature range studied. The separation allowed a prediction of λ at temperatures greatly exceeding the range of actual experimental measurements. The Lorentz function was calculated and found to be very near the Sommerfeld value at temperatures of 300°K and above. In order to make high-quality samples, a zone-melting technique was developed that converted the metal directly into the nitride at a state ~100 times as fast as conventional techniques. The fabricated samples were nearly 100% dense with very large grains of ~0.3 cm dia. (TSS) (Diss. Abstr. Int., B)

55028 1971 DIGESTS OF THE INTERMAG CONFERENCE, DENVER, COLORADO, APRIL 13–16, 1971. 71 C 12-MAG. New York; Institute of Electrical and Electronics Engineers, Inc. (1971). 187p. $4.00. (CONF-710446).

The 214 papers were presented in 33 sessions dealing with: ferrites, domain devices and techniques, magneto-optics, charge transfer devices and magnetic bubbles, recording media and techniques, cobalt rare earth magnets, instruments, video recording, bubble materials, memory devices and systems, electromechanical devices, storage hierarchies, magnetic recording theory, low-coercivity materials, permanent magnets, ferroresonant regulators and power conditioning, bulk storage, garnets, hard materials, recording heads, magnetization processes, plated-wire memory, microwave materials and resonance, and microwave integrated circuits. (D.L.C.)

55029 PARAMAGNETIC RELAXATION INITIATED BY FLUX JUMPING. Griffiths, D. J. (Oregon State Univ., Corvallis). Phys. Lett.; 41A: No. 1, 21-2(28 Aug 1972).

Controlled flux jumping of type-II superconductors was used to produce nonequilibrium spin distributions in Ce^{3+} 1 at.%: CaF_2. The subsequent return to thermal equilibrium was examined by monitoring the magnetic-optical Faraday effect of the cerium ions. (auth)

55030 MAGNETIC SUSCEPTIBILITIES OF NONSTOCHIOMETRIC CERIUM OXIDES. Ariya, S. M.; Balashova, E. P. Vestn. Leningrad. Univ., No. 22, Fiz., Khim.; No. 4, 151-2(Nov 1971). (In Russian).

Magnetic susceptibilities of some nonstoichiometric cerium oxides were measured. Magnetic moments calculated for a Ce(III) atom approach the value of $\mu = \sqrt{J(J+1)} = 2.56\ \mu_B$. (auth)

55031 VIBRATIONAL SPECTRA AND STRUCTURES OF RARE EARTH OXIDES IN THE A MODIFICATION. Denning, J. H.; Ross, S. D. (Chelsea Coll. of Science and Tech., London). J. Phys., C (London); 5: No. 11, 1123-33(12 Jun 1972).

Crystallographic studies of La_2O_3 and the oxides isostructural with it failed to decide between the noncentrosymmetric space group D_3^3(P321) and the centrosymmetric space group D_{3d}^3(P$\bar{3}$m 1) for their structure. The infrared and Raman spectra of La_2O_3 and Nd_2O_3 were obtained, and the absence of coincidences between the spectra unequivocally favors the centrosymmetric space group. The vibrational spectra were analyzed using the Wilson FG matrix method and force constants for metal–oxygen and oxygen–oxygen interactions derived, assuming a quadratic central force field. (auth)

55032 SPECTROSCOPY OF RARE EARTH OXIDE SYSTEMS. I. FAR INFRARED SPECTRA OF THE RARE EARTH SESQUIOXIDES, CERIUM DIOXIDE, AND NONSTOICHIOMETRIC PRASEODYMIUM AND TERBIUM OXIDES. Bloor, D.; Dean, J. R. (Queen Mary Coll., London). J. Phys., C (London); 5: No. 11, 1237-52(12 Jun 1972).

The far-infrared spectra of the rare earth sesquioxides, cerium dioxide, and nonstoichiometric praseodymium and terbium oxides were observed over the range 10 to 250 cm^{-1} at liquid helium temperatures. Absorptions due to the excitation of phonons and low-lying electronic states of the rare earth ions occur in this region. The long-wavelength phonons in the sesquioxides involve motions of the rare-earth ions in an effectively rigid oxygen lattice. To a first approximation, the absorptions can be described using the rare-earth-ion site symmetries. This, together with observations of the linewidths and frequencies in mixed crystals, suggests that these phonons have the character of a local resonant mode. Strong interactions between these phonons and the electronic excitations of the rare-earth ions were observed. In general, the observed electronic energies agree with those obtained by less direct methods; however, in a few cases significant differences were found. The spectra of the other oxides indicate the presence of complex or mixed phases. (auth)

55033 MAGNETIC STRUCTURE OF $HoAu_2$. Atoji, Masao. (Argonne National Lab., Ill.). J. Chem. Phys.; 57: No. 6, 2402-6(15 Sep 1972).

Neutron-powder diffraction measurements reveal that $HoAu_2$ (the tetragonal body-centered CaC_2-type structure) becomes an antiferromagnet below $T_N(\alpha) = 9.2$°K with the onset of an incommensurate moment alignment (α) having a transverse wave modulation. The α magnetization wave with the wavelength, 6.373 Å = 1.229 a, propagates along the a axis and is polarized approximately in the direction of the b axis, all in the face-centered lattice description. At $T_N(\beta) = 7.8$°K, a commensurate transverse magnetization wave (β) starts to grow. The β wave with the wavelength equal to the a spacing propagates along the a or b axis and is polarized in the direction of the c axis. The composite configuration of the α and β transverse waves may be described as an antiferromagnetic triangular-fan structure. In cooling, the α wave amplitude reaches rapidly to a maximum value of 6.7 μ_B at 6.3°K, then decreases monotonically, and diminishes near 0°K. The β wave moment follows the Brillouin curve and approaches 6.4 μ_B at 0°K. The composite ordered moment rises to a maximum value of 7.8 μ_B at around 5.5°K and declines toward 6.4 μ_B at 0°K. These moment values which are considerably smaller than 10 μ_B of the free Ho^{3+} ion indicate a strong crystal field effect. The phenomenon that the maximum composite moment occurs near the midpoint of the ordered phase is due likely to a strongly anisotropic, competing interaction between the RKKY exchange coupling and the crystal field effect. (auth)

55034 MAGNETIC STRUCTURE OF $ErAu_2$. Atoji, Masao (Argonne National Lab., Ill.). J. Chem. Phys.; 57: No. 6, 2407-9(15 Sep 1972).

The magnetic properties of $ErAu_2$ having the tetragonal body-centered CaC_2-type structure were investigated at temperatures between 297 and 1.8°K by neutron diffraction experiments on powdered specimens. The onset of an incommensurate, transverse wave moment alignment (the α structure) occurs at 6.7°K. The α magnetization wave propagates along the a axis and is polarized in the b direction, all in the face-centered description. The α wavelength is 6.443 Å = 1.248 a and is temperature independent. At 4.0°K, a commensurate antiferromagnetic moment wave (the β structure) appears with the propagation direction parallel to the a axis. The β wavelength is equal to the a spacing. As regards the β moment components, the x || a component is slightly larger than the y || b component and the z || c component is undetectably small. The composite configuration of the α and β waves delineates a distorted-fan modulation. In cooling, the α amplitude develops to 6.7 μ_B at 4°K, then decreases to 5.9 μ_B near 3°K, and retains 5.9 μ_B at $3 > T > 0$°K. The β wave moments approximate the Brillouin magnetization with the extrapolated moments of 3.2 and 2.7 μ_B at 0°K for the x and y components, respectively. The maximum composite moment is 9.2 μ_B at 0°K, while the ordered moment of the free Er^{3+} ions is 9.0 μ_B. (auth)

55035 MAGNETIC AND CRYSTAL STRUCTURES OF ErC_2 AT 297 -2°K. Atoji, Masao (Argonne National Lab., Ill.). J. Chem. Phys.; 57: No. 6, 2410-13(15 Sep 1972).

Neutron-powder diffraction measurements show that the tetragonal body-centered ErC_2 becomes antiferromagnetic below 19 ± 2°K. The moment alignment is governed by several narrowly dispersed, incommensurate transverse magnetization waves. The major modulation waves propagate along the a axis and are polarized in the b axis direction. The magnetization wavelengths are 5.78, 5.4, 6.7, and 7.1 Å, and the amplitudes are respectively 6.55, 2.2, 2.1, and 1.6 μ_B at 4.2°K. The ferromagnetic alignment in the plane perpendicular to a is slightly altered by several long-periodicity modulations propagating along the b and c axes. A commensurate, antiferromagnetic wave also participates in the moment alignment below 10 ± 3°K. The commensurate wave is represented by setting the wavelength equal to the a spacing in the incommensurate wave mode. The commensurate moment is 2.5 μ_B at 4.2°K. The root-mean-square value of all the moment amplitudes is 7.8 μ_B at 4.2°K and increases to 7.9 μ_B at 2°K. These features are likely caused by a strong perturbation between the RKKY coupling and the crystal-field effect. The proposed structure is by no means unique, although an exhaustive search for other probable models was fruitless. The crystal structure is characterized by the C–C bonding distance of 1.288 ± 0.006 Å and the Er–C distances of 2.403 ± 0.003 and 2.640 ± 0.001 Å. These distances are indicative of a large 5d–$\pi_0$2p contribution in the conduction-band wavefunction. (auth)

55036 ESR STUDY OF THE PYROLYSIS OF HYDROGEN ON TUNGSTEN. Cochran, Edward L.; Bowers, Vernon A.; Adrian, Frank J. (Johns Hopkins Univ., Silver Spring, Md.). J. Chem. Phys.; 57: No. 6, 2384-8(15 Sep 1972).

Electron spin resonance (ESR) techniques were adapted to the study of the atomization of hydrogen occurring on the surface of heated filaments. The method involves heating an axial metal filament in a circular cavity to temperatures of 1000 to 2000°K and measuring the steady-state atom concentration produced in the gas. Heating is accomplished by dc current pulsed at 6000 pulses/sec with a 15% duty cycle. Under these conditions, the sample space is free a relatively high proportion of the time from current-induced field inhomogeneities. The sensitivity and spectral line shapes observed compare favorably with those observed in control experiments in the same cavity in the absence of the heated filament. The atomization of hydrogen on tungsten filaments can be conveniently studied by ESR at hydrogen pressures between 0.1 and 100 torr; thus, this method complements previously developed techniques that are most useful at lower pressures (10^{-6} to 10^{-2} torr). The observed pressure and temperature dependences of the H atom concentration are interpreted in terms of a mechanism involving the production of hydrogen atoms on the filament, their diffusion into the gas, and recombination on the cavity wall. The surface reaction appears to be complex, changing character at an H_2 pressure somewhere around 0.5 torr. Extrapolation of the ESR data to very low H_2 pressures yields results consistent with previous low pressure studies. At higher H_2 pressures the rate of H atom production decreases due to surface saturation effects. (auth)

55037 INHOMOGENEOUS MAGNETIC SYSTEMS. Neumann, L. (Siemens AG, Erlangen, Ger.). Z. Phys.; 253: No. 5, 404-14(1972). (In German).

Within the molecular-field approximation the Gibbs free energy G is calculated for a system with inhomogeneous distribution of magnetic particles. Some properties of such a system derivable from G are compared with magnetic and calorimetric measurements on $Ce_{1-x}Gd_xRu_2$ alloys. (auth)

55038 ATOMIC POSITIONS IN THORIUM SILICATE: AN X-RAY-DIFFRACTION STUDY. Sinha, Devendra Prasad (Patna Univ., India); Prasad, Rameshwar. Indian J. Phys.; 45: No. 9, 435-7(Sep 1971).

The structural study of thorite (thorium silicate) was extended to the powder method using the Hull–Davey chart. The best agreement of observed and calculated intensities was obtained for the tetragonal system. The space group was found to be D_{4h}^{19}–$I4_1/amd$. The bond distances are: Th–4O, 2.51 Å; Th–4O, 2.45 Å; and Si–4O, 1.56 Å. (D.L.C.)

55039 STABILITY OF A TRANSVERSE-WAVE MAGNETIC STRUCTURE AT 1.3 K. Gignoux, D.; Lemaire, R.; Paccard, D. (Laboratoire de Magnetisme, Grenoble, France). Phys. Lett.; 41A: No. 2, 187-8(11 Sep 1972).

Some $TbN_{1-x}Cu_x$ exhibit sinusoidal wave magnetic structures between 1.3°K and T_N. When the crystal-field splitting is pre-

ponderant, the ordered moment can be induced by exchange field which explains the stability of these structures down to 0°K. (auth)

55040 INFLUENCE OF PLASTIC DEFORMATION AND RECRYSTALLIZATION UPON PERMEABILITY ANOMALIES IN GADOLINIUM METAL. Milstein, Frederick; Zyvoloski, George (Univ. of California, Santa Barbara). J. Appl. Phys.; 43: No. 10, 4217-25(Oct 1972).

Polycrystalline gadolinium metal was plastically deformed by a cold-rolling technique and measurements were subsequently made of the weak-field ac relative permeability as a function of temperature. The Gd was then subjected to a recrystallization anneal, and the magnetic measurements were repeated as a function of temperature. Results observed are (i) in the annealed state, the permeability passes through an anomalous "hump" in the neighborhood of the Curie temperature; this anomaly is absent in the plastically deformed state, (ii) in a range of temperatures below the Curie temperature, the relative permeability in the work-hardened state is greater than that in the annealed state, and (iii) at a lower temperature (about 240°K), the relative permeability in the annealed state undergoes a further, sharp increase which is much greater than that which occurs at the Curie point; this lower temperature increase in relative permeability is largely suppressed in the work-hardened state. The experimental results are discussed in terms of the influence of the cold-rolling process upon magnetocrystalline anisotropy and in terms of the relative importance of domain rotation and domain-wall movement in the plastically deformed and in the annealed state. (auth)

55041 LIGHT SCATTERING IN SOLIDS. Proceedings of the Second International Conference, Paris, July 19-23, 1971. Balkanski, M. (ed.). Portland, Oreg.; International Scholarly Book Services, Inc. (1971). 529p. $45.00. (CONF-710720).

Approximately 120 papers and abstracts were presented on problems concerning the light scattering by elementary excitations in solids. Subjects covered include: resonant Raman effects, electronic excitations, magnetic excitations, stimulated light scattering, polaritons, phonons, phase transitions, and Brillouin and Rayleigh scattering. Separate abstracts were prepared for two of the papers. Subject and author indexes are included. (D.L.C.)

For abstracts of individual papers see: 55042 and 55043.

55042 BOUND STATE IN EuO. Thorpe, M. F. (Yale Univ., New Haven). pp 161-4 of Light Scattering in Solids. /Balkanski, M. (ed.). Portland, Oreg.; International Scholarly Book Services, Inc. (1971).

From International conference on light scattering from fluids; Paris, France (15 Jul 1971). See CONF-710720.

Techniques for finding the two-magnon states in ferromagnets are used to show that an optically active bound state exists in an fcc Heisenberg ferromagnet with nearest-neighbor exchange. The repulsive interaction between magnons with equal and opposite momentum near the zone boundary does not lead to a bound state in most lattices. However, the magnon dispersion in an fcc lattice is such that there is a logarithmic divergence in the density of states at the largest single magnon energy, which causes a bound state to be split off above the band. These ideas are applied to EuO, which has a transition temperature of 69.3°K and therefore a two-magnon band stretching from 0 to 109 cm^{-1}, if the exchange is entirely nearest neighbor. The bound state is predicted to be above the band by only 0.05 cm^{-1} because of the large spin of the Eu^{2+} ion. Experimentally, one should be able to see a rather sharp peak at the top of the two-magnon band due to the smoothed out logarithmic singularity. (auth)

55043 RAMAN SCATTERING IN THE SEMICONDUCTING AND METALLIC PHASES OF VO_2. Chase, L. L.; Srivastava, Ramakant (Indiana Univ., Bloomington). pp 380-4 of Light Scattering in Solids. /Balkanski, M. (ed.). Portland, Oreg.; International Scholarly Book Services, Inc. (1971).

From International conference on light scattering from fluids; Paris, France (15 Jul 1971). See CONF-710720.

The Raman scattering spectrum of VO_2 single crystals is studied above and below the semiconducting-to-metal transition at 68°C. In the monoclinic semiconducting phase, only sharp phonon structure is observed in contrast with the isomorphic material, TiO_2, which also has broad, intense multiphonon bands. No unusual temperature dependence is observed in the positions or intensities of these lines. In the metallic phase only heavily damped features are observed, a result which clearly distinguishes VO_2 from the corundum-structure sesquioxides which exhibit insulator-metal transitions. A reasonable interpretation for the one resolved scattering peak in the metallic phase suggests that the rutile-structure A_{1g} mode softens by about 15% of its value in the semiconducting phase. The implications of this result in understanding both the mechanism for the phase transition and the electron-phonon interactions in the metallic phase are discussed. (auth)

55044 DOPPLER-SHIFTED CYCLOTRON RESONANCE IN CADMIUM. Konstantinov, O. V.; Skobov, V. G.; Lavrova, V. V.; Fisher, L. M.; Yudin, V. A. (Physical-Technical Inst., Moscow). Zh. Eksp. Teor. Fiz.; 63: No. 1, 224-41(Jul 1972). (In Russian).

The Doppler-shifted cyclotron resonance in cadmium in a magnetic field H||[0001] is studied theoretically and experimentally in the radio-frequency region. The resonance is due to carriers with extreme shifts during the cyclotron period. Dispersion of the dielectric permeability related to the resonance leads to the appearance of weakly damped waves—dopplerons. It is found that beside dopplerons, due to lens electrons, there exist hole dopplerons related to orbits near the central cross section of the monster. Excitation of this type of doppleron in cadmium plates leads to surface-resistance oscillations with amplitudes that appear in weaker magnetic fields than do oscillations of the electron doppleron. The regions of existence of both types of dopplerons are bounded from the weak magnetic field side. The effect of the shape of the Fermi surface on the doppleron spectrum and position of the boundary fields is studied. The shape of the electron lens is determined by comparing the theoretical and experimental results. The value of the derivative of the monster cross section area with respect to momentum derived from oscillation period measurements is in agreement with the monster model employed. (tr-auth)

55045 MAGNETIZATION, VELOCITY OF SOUND, AND SPECIFIC HEAT OF Sc_3In. Testardi, L. R.; Holmes, L. M.; Reed, W. A.; Hsu, F. S. L. (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev., B; 6: No. 9, 3365-70(1 Nov 1972).

The magnetization at 1.5 and 4.2°K and the velocity of sound in zero field of Sc_3In from 1.5 to 300°K and in applied fields at 1.5 and 4.2°K are reported. The magnetic behavior exhibits essentially no coercive field, remanence, or hysteresis. A thermodynamic formula is obtained relating the field dependence of the velocity of sound with magnetostriction and magnetic susceptibility. A qualitatively successful comparison is made using the results and the magnetostriction data of Fawcett and Meincke. Specific-heat data at zero field and 1.3 kOe are reported and are related thermodynamically to the magnetization data. (auth)

55046 MAGNETIC SUSCEPTIBILITY OF RHENIUM TRIOXIDE. Greiner, John D.; Shanks, Howard R. (Ames Lab., Iowa). J. Solid State Chem.; 5: No. 2, 262-5(Sep 1972).

Magnetic susceptibility measurements were made on ReO_3 as a function of temperature between 77 and 300°K. The results of the measurements show that ReO_3 has a temperature-independent paramagnetism of 0.086×10^{-6} emu/g. A separation of the individual contributions to the measured susceptibility is made and the resultant values are compared with data on cubic sodium tungsten bronzes. The agreement indicates strong similarities between the properties of ReO_3 and Na_xWO_3 as x approaches 1. (auth)

55047 LOW-TEMPERATURE HEAT CAPACITY OF $LaRu_2$, $CeRu_2$, AND $CeRu_{2-x}Pt_x$. Joseph, R. R.; Gschneidner, K. A. Jr.; Koshimaki, D. C. (Ames Lab., Iowa). Phys. Rev., B; 6: No. 9, 3286-96(1 Nov 1972).

The heat capacity of two samples of $CeRu_2$ and one sample each of $CeRu_{1.9}Pt_{0.1}$, $CeRu_{1.8}Pt_{0.2}$, and $LaRu_2$ were measured from 1.3 to 9°K (to 20°K for $LaRu_2$). All samples are superconducting, have high γ values (10 to 14 mJ/g atom $°K^2$), and moderately low Debye temperatures (144-158°K). None of these materials behaves as a BCS-type superconductor. All of these materials exhibit a departure from the normal T^3 behavior at a temperature $\frac{1}{3}$ to $\frac{1}{2}$ of that which might be expected from the Debye theory. The departure is unusual in that the Debye temperature increases with increasing temperature, while other Laves-phase compounds that were recently examined show the opposite and more normal (?) behavior. These different behaviors are explained on the basis of the structural nature of the Laves phase. (auth)

55048 s-d EXCHANGE MODEL OF WEAK FERROMAGNETISM WITH AN APPLICATION TO MnB_2. Robinson, J. M.; Erdoes, Paul (Florida State Univ., Tallahassee). Phys. Rev., B; 6: No. 9, 3337-43(1 Nov 1972).

A crystalline solid is considered with two types of exchange interactions: a direct exchange coupling of localized spins and s-d or s-f exchange between localized spins and conduction electrons. The model developed is a generalization of the theory proposed by Kasaya and Hihara to explain the weak ferromagnetism of MnB_2. In contrast to the latter theory, the finite spatial extension of the d or f wave functions and the distortion of the electronic energy bands induced in the ordered state by the s-d or s-f interactions are taken into account and significantly affect the criteria for weak ferromagnetism. Comparisons are made to the Zener and Rudermann-Kittel-Kasuya-Yosida theories, which are limiting cases of the theory presented. In particular, the nonlinear response of the conduction electrons to the exchange field

is demonstrated, with important implications for first-order magnetic phase transitions. (auth)

55049 CRITICAL DIVERGENCE OF THE THERMAL RESISTIVITY AT THE NEEL POINT OF EUROPIUM. Sze, N. H.; Meaden, G. T. (Univ. of Dalhousie, Hailfax, Nova Scotia). J. Phys., F (London) 2: No. 4, 693-8(Jul 1972).

The appearance of a λ-shaped peak in the temperature coefficient of the thermal resistivity of europium at its magnetic critical point provides the first experimental evidence for the critical divergence of this transport property in a metallic element. In discussing the results, comparison is made with critical divergences observed for the magnetic heat capacity and the temperature coefficient of the electrical resistivity. (auth)

55050 MAGNETIC TRANSITIONS IN THE RARE EARTH INTERMETALLIC COMPOUNDS R_3Ni AND R_3Co. Primavesi, G. J.; Taylor, K. N. R. (Univ. of Durham, Eng.). J. Phys., F (London); 2: No. 4, 761-70(Jul 1972).

Measurements were made of the magnetic properties of rare earth–transition metal compounds having the Fe_3C structure. Results obtained using a pulsed-field magnetometer are appreciably different from those observed previously in static fields by other workers. It is difficult to decide from these results what type of magnetic order is present in several of the compounds. It is clear, however, that in some cases the observed magnetization is time-dependent. (auth)

55051 PHASE TRANSITION IN SAMARIUM. Bulatov, A. S.; Finkel, V. A. (Physical-Technical Inst., Kiev). Zh. Eksp. Teor. Fiz.; 63: No. 1, 213-16(Jul 1972). (In Russian).

The crystal structure of samarium at 77 to 300°K is studied by the low-temperature x-ray-diffraction technique. It is shown that at T ~ 106°K there is a phase transition of the second kind that is apparently related to the paramagnetism–antiferromagnetism transformation. The discontinuous changes of the linear expansion coefficients at 106°K are pronouncedly anisotropic: $\Delta\alpha_\perp < 0$, $\Delta\alpha_\parallel > 0$. With decrease of the temperature below 106°K, the period a of the nine-layer hexagonal compact lattice is found to increase. (tr-auth)

55052 THEORY OF THE VOID LATTICE IN MOLYBDENUM. Tewary, V. K.; Bullough, R. (Atomic Energy Research Establishment, Harwell, Eng.). J. Phys., F (London); 2: No. 4, L69-72(Jul 1972).

A model is proposed for the study of various physical properties associated with the void lattices as recently observed in several metals. The model gives the correct value for the equilibrium void lattice spacing in molybdenum and also explains the stability of the void lattice. (auth)

55053 DIRECT FITTING OF SPIN WAVE ENERGIES TO INTERATOMIC EXCHANGE PARAMETERS IN THE FERROMAGNETIC RARE EARTH METALS. Stevens, W. N. R. (Univ. of Manitoba, Winnipeg). J. Phys., F (London) 2: No. 4, 797-805(Jul 1972).

The description of wave vector dependence of spin wave energy in the ferromagnetic rare-earth metals in terms of interatomic Heisenberg-exchange parameters is considered. Limitations on the exchange coupling information given by the forms of published inelastic-neutron-scattering measurements are demonstrated. The results of a maximum possible analysis of available data for terbium at 90°K are given. The problem of choosing a set of points in reciprocal space for measurement of spin wave energies to obtain a complete description of the exchange coupling (within the Heisenberg model) to the maximum precision is discussed. In general a broad distribution of points through the volume of the zone is desirable. It is found that the intrasublattice coupling can be fully determined to quite a good precision from a relatively small number of measurements but the intersublattice coupling is not as easily determined. (auth)

55054 CRYSTAL FIELD EFFECT ON THE DIRECTION OF MAGNETIC MOMENTS OF RARE EARTH IONS WITH LOW SYMMETRY SITES ($C2-C_s$). Rossat-Mignod, J.; Tcheou, F. (CEN, Grenoble, France). J. Phys. (Paris); 33: No. 4, 423-8(Apr 1972). (In French)

It is possible to determine the direction of the magnetic moment in rare-earth compounds of low symmetry sites, using a crystal-field calculation in the point-charge model. This method was applied to Tb_2O_3 and different rare-earth perovskites. The results are in good agreement with experimental results. (France)

Moessbauer Effects and NMR

Refer also to abstracts 54646 and 54661.

55055 (IS-T-529) MOESSBAUER EFFECT STUDY OF ^{57}Fe IN TRANSITION METAL BORIDES. DeYoung, Donald Bouwman (Ames Lab., Iowa). Aug 1972. Contract W-7405-eng-82. 97p. Dep. NTIS.
Thesis.

The phase characteristics and nuclear hyperfine properties of sixty different transition-metal borides were studied by Moessbauer effect spectroscopy. The prepared mixed iron–transition metal boride phases include MB_2, M_3B_4, MB, M_3B_2, and M_2B types. Transmission experiments with powders were completed in the range 4.2 to 1000°K; additional scattering and 18-kOe applied-field data was collected at 300°K. Measured nuclear hyperfine parameters are discussed in terms of atomic bonding, charge transfer, and spontaneous magnetism in the borides. Isomer-shift data for all phases indicate an electron transfer from boron to the metal 3d band. The effective magnetic field of ferromagnetic monoborides is proportional to the magnetization, and also reveals a possible charge transfer from B to M. Quadrupole coupling results show a strong ionic contribution to the electric field gradient at the ^{57}Fe nucleus in monoborides. A region of ferromagnetism below 173°K was found in ternary $M_2M'B_2$ borides, where M is Mo or W and M' is a 3d transition metal. Moessbauer-effect studies of FeB reveal two distinct modifications, including a defect α phase. (auth)

55056 INTENSITY OF THE QUADRUPOLE STRUCTURE IN THE ^{51}V NMR IN TRANSITION-METAL ALLOYS. Nakajima, H.; Komori, N.; Mori, N. (Hokkaido Univ., Sapporo, Japan). Phys. Lett.; 41A: No. 1, 89-90(28 Aug 1972).

The intensity variation of the quadrupole satellite of the ^{51}V magnetic resonance was studied relative to alloying concentrations in σ-phase V–Co alloys. The nearest-neighbor atoms play the most important role in this fine structure. (auth)

55057 CHARGED STATE OF ^{57}Fe ATOMS FOLLOWING THE DECAY OF ^{57}Co IN SOLID XENON. Micklitz, H.; Barrett, P. H. (Univ. of California, Santa Barbara). Phys. Rev. Lett.; 28: No. 24, 1547-50(12 Jun 1972).

Moessbauer studies with ^{57}Fe atoms following the decay of ^{57}Co in solid Xe find these atoms in two states: the stable Fe $3d^64s^2$ state and an unstable Fe^+ $3d^7$ state. The isomer-shift analysis yields $\Delta R/R = -(8.7 \pm 0.3) \times 10^{-4}$ for the 14.4-keV γ transition in ^{57}Fe. Information is obtained about the charge-transfer mechanism and recombination time of Fe ions in solid xenon. (auth)

55058 STUDY OF BIOLOGICAL MACROMOLECULES USING PERTURBED ANGULAR CORRELATIONS OF GAMMA RADIATION. Meares, Claude F.; Westmoreland, David G. (Stanford Univ., Calif.). Cold Spring Harbor Symp. Quant. Biol.; 36: 511-16(1972).

Preliminary results indicate the potential usefulness of the perturbed angular correlation technique for studies of the motional properties of labeled macromolecules and for in vivo experiments at concentrations of $^{111}In^{3+}$ as low as 10^{-12} M. Exploitation of these advantages is currently hindered by the lack of chemical selectivity of $^{111}In^{3+}$. Applications of this method will be greatly broadened by the development of a labeling reagent which incorporates a strong complexing agent and a reactive group, such as a sulfhydryl reagent. With this reagent, it should be possible to attach indium to interesting regions of biological macromolecules. A program for the synthesis of such a label is currently in progress. (auth)

55059 NMR INVESTIGATIONS ON Y- AND La-DILUTED GdZn. Eckrich, K. (Technische Hochschule, Darmstadt, Ger.); Dormann, E.; Pppelt, A.; Buschow, K. H. J. Phys. Lett.; 41A: No. 1, 23-4(28 Aug 1972).

Gd, La, and Zn zero-field resonances are observed in ferromagnetically ordered $Gd_{1-x}La_xZn$ and $Gd_{1-x}Y_xZn$. Zn satellite lines allow the determination of the contribution of the nearest Gd neighbor shell to the Zn hyperfine field. (auth)

55060 ANGULAR CORRELATION OF A GAMMA CASCADE 329 TO 487 keV IN ^{140}Ce. Georgieva, M. K.; Misheva, M. A.; Tumbev, G. Kh. (Inst. of Physics, Sofia). Compt. Rend. Acad. Bulg. Sci.; 25: No. 2, 181-3(1972). (In Russian).

The cascade gamma transition from 329 to 487 keV in ^{140}Ce is convenient for investigating magnetic fields in various media by the method of perturbed gamma angular correlations. An unsaturated solution of $La(NO_3)_3$ was irradiated with thermal neutrons to produce a source which could be studied with sufficiently high accuracy for parameters of the unperturbed angular correlation of this cascade. (K.S.W.)

55061 MOESSBAUER EXPERIMENTS ON THE LIFETIME OF EXCITED NUCLEI. Kamenov, P. S. (Univ., Sofia). Compt. Rend. Acad. Bulg. Sci.; 25: No. 2, 185-8(1972).

New Moessbauer experiments on the detailed study of the life-

time of excited nuclei in the region of the resonance curve are suggested. The experiments will determine whether the formula of Messiah is the correct one: $\Delta t = (2h/\Gamma_0)\ (\Gamma_0^2/4(E - E_0)^2 + \Gamma_0^2)$. (D.L.C.)

55062 FEASIBILITY OF A γ LASER BASED ON RADIOACTIVE CRYSTALS. Khokhlov, R. V. (Moscow State Univ.). JETP Lett. (USSR) (Engl. Transl.); 15: No. 9, 414-16(5 May 1972). Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 15: No. 9, 580-3(5 May 1972).

The possibility of a γ laser based on Moessbauer radiation is considered. It is shown that, in principle, it is possible to produce a γ laser using long-lived nuclear isomers. (D.L.C.)

55063 THEORY OF THE NUCLEAR QUADRUPOLE INTERACTION IN TERMS OF IRREDUCIBLE TENSORS. Hollingworth, R. W.; Hacobian, S. (Univ. of Sydney). Aust. J. Chem.; 25: No. 4, 683-93(Apr 1972).

Using irreducible tensors throughout, the theory of the interaction of a quadrupolar nucleus surrounded by electrons is presented. The theory is applied both to pure and Zeeman nqr spectra. The relation between the spectroscopic and intrinsic quadrupole moments is derived. (auth)

55064 POSITRON LIFETIMES AND PHASE TRANSITIONS IN SOLIDS. Singh, K. P.; Singru, R. M.; Rao, C. N. R. (Indian Inst. of Tech., Kanpur). J. Phys., C (London); 5: No. 10, 1067-71(25 May 1972).

Lifetimes of positrons annihilating in NH_4Cl and in nitrate glasses were measured as a function of temperature. The observed temperature dependence of τ_2 and I_2 indicates that the I_2 is significantly affected by changes in molar volume accompanying the phase transitions in these solids. I_2 varies in the same direction as the molar volume thus underlining the role of free volume in the positron annihilation process in condensed media. (auth)

Theory

55065 (UCRL-Trans-10643) LONGITUDINAL AND TRANSVERSE EXCITONS IN SEMICONDUCTORS. Denisov, M. M.; Makarov, V. P. (Akademiya Nauk SSSR, Moscow. Fizicheskii Institut). Translated for Univ. of California, Lawrence Livermore Lab. from Preprint No. 78. 15p. Dep. NTIS.

Formulae for the energy of longitudinal excitons in semiconductor crystals with arbitrarily complex band structure are derived from purely microscopic and from phenomenological considerations. The results coincide, as they should. These results are compiled with those of other theoretical studies and with existing experimental data. (auth)

55066 POSITRON CORRELATION ENERGY IN METALS. Bergersen, B.; Carbotte, J. P. (McMaster Univ., Hamilton, Ont.). Can. J. Phys.; 50: No. 12, 1332-6(15 Jun 1972).

The positron correlation energy in an electron gas is calculated in the metallic density region using the random phase dielectric constant. It is found that the positron–plasmon interaction is much more important for the correlation energy than for the annihilation rate, and that the plasmon contribution to the energy is actually larger than the particle–hole contribution. Calculations using the Singwi et al. dielectric constant give essentially the same results as the RPA. It is argued that the ladder approximation need not represent an improvement over linear response theory when computing the correlation energy. (auth)

PHYSICS (THEORETICAL)

Refer also to abstracts 54392, 54408, 54682, and 54797.

55067 (ITF-72-9-E) ON THE SOLUTIONS OF BOGOLYUBOV KINETIC EQUATIONS. QUANTUM STATISTICS. Petrina, D. Ya. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1972. 24p. Dep. NTIS (U. S. Sales Only).

The Bogolyubov kinetic equations for quantum statistics are investigated. A method due to Bogolyubov is used to investigate the solutions of kinetic equations in the Banach space composed of a sequence of trace-class operators in the state space. The procedure makes it possible to construct the solutions of kinetic equations in a finite volume by using the physically meaningful initial data. The weak, or smoothed, solutions are constructed in the space of bounded operators. (auth)

55068 (ITF-72-31-P) ASYMPTOTICALLY EXACT SOLUTIONS FOR THE SYSTEMS WITH SINGULAR POTENTIALS. Simenog, I. V. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1972. 22p. (In Russian). Dep. NTIS (U. S. Sales Only).

It is shown that for the quantum-mechanical systems with singular attractive potentials, the Hartree approximation is realized in an asymptotically exact way in the limit of a great number of particles N. The Hartree one-particle solutions are also asymptotically exact for the systems with a bounded monotone potential of interactions. (auth)

55069 (ITF-72-36-E) PRODUCT FORMULA FOR SEMIGROUPS AND ITS APPLICATION TO THE SCHROEDINGER EQUATION WITH SINGULAR POTENTIALS. Semenov, Yu. A. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1972. 22p. Dep. NTIS (U. S. Sales Only).

The class of potentials for which the solution of the Schroedinger equation is representable as the Feynman integrals over a trajectory are investigated. It is proved that in the attractive case all the potentials allowed by the principal postulates of quantum mechanics are such that if a total Hamiltonian of the system is defined by the bilinear form method, then the Feynman integral over a trajectory converges to the propagation. (auth)

55070 (ITF-72-45-P) RELATIONS BETWEEN THE MOMENT FUNCTIONALS OF MEASURES ABSOLUTELY CONTINUOUS WITH RESPECT TO THE GAUSSIAN MEASURE AND THE SOLVABILITY OF SCHWINGER EQUATIONS FOR THE GREEN FUNCTIONS OF A EUCLIDEAN FIELD THEORY. Gonchar, N. S. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1972. 35p. (In Russian). Dep. NTIS (U. S. Sales Only).

The solvability of Schwinger equations for the Green's functions of a Euclidean field theory is investigated for any nonlinear self-interaction bounded from below. First, the "cut off" equations in which all the values are mathematically meaningful are investigated. In this case the representation in terms of a functional integral in some probability measure is obtained for a solution. The vector S_α, which is the solution, belongs to a space $\bar{S}$. Then a "cut off" theory with essentially nonlinear bounded Lagrangians of interaction is investigated. It is shown that in this case the limiting Green's functions coincide with the free Green's functions. (auth)

55071 (LA-4868) DERIVATION OF THE BOLTZMANN DISTRIBUTION LAW WITH ILLUSTRATIONS FROM A HARD-SPHERE MODEL COMPUTER PROGRAM. Conant, Donald R. (Los Alamos Scientific Lab., N. Mex.). Jun 1972. Contract W-7405-eng-36. 16p. Dep. NTIS.

The Boltzmann distribution law is derived, and examples illustrating differences among the assumptions of Boltzmann, Bose–Einstein, and Fermi–Dirac statistics are given. The range of applicability of the assumptions and the distortions of molecular systems caused by this limited range are discussed. Results from a hard-sphere model calculated by computer are used to illustrate the distortions and the rather good agreement with the Boltzmann prediction for energies near the average molecular energy even for systems containing only a few molecules. (auth)

55072 APPLICATION OF ORTHOGONAL AND UNITARY GROUP METHODS TO THE N-BODY PROBLEM. Louck, James D. (Los Alamos Scientific Lab., N. Mex.); Galbraith, Harold W. Rev. Mod. Phys.; 44: No. 3, 540-601(Jul 1972).

Methods for constructing states of good total orbital angular momenta of N identical, free, structureless particles through the use of the orthogonal and unitary groups are developed. The first part reviews the existing literature, particularly for the three-particle problem. New results include the discrete symmetry properties of the SU(3) states vectors of the three-particle problem. The general N-particle problem is approached through the use of the subgroup property O (n) $\subset$ U (n). An imbedding of O (n) in U (n) is given which greatly simplifies the study of the O (n) subgroup of U (n). Particular applications of this imbedding are: (1) an explicit constructive procedure for obtaining all the single-valued irreducible representations of O (n), and (2) an explicit constructive procedure for obtaining all N-particle states of good angular momenta up through the degree four solid harmonics. (auth)

55073 ASPECTS OF TIME-DEPENDENT PERTURBATION THEORY. Langhoff, P. W. (Harvard Univ., Cambridge, Mass. Indiana Univ., Bloomington); Epstein, S. T.; Karplus, M. Rev. Mod. Phys.; 44: No. 3, 602-43(Jul 1972).

The Dirac variation-of-constants method has long provided a basis for perturbative solution of the time-dependent Schrödinger equation. In spite of its widespread utilization, certain aspects of the method have been discussed only superficially and remain somewhat obscure. The present review attempts to clarify some of these points, particularly those related to secular and normalization terms. Secular terms arise from an overall time-dependent phase in the wave function, while normalization terms preserve the norm of the wave function. A proper treatment of the secular terms is essential in the presence of a physically significant level shift that can produce secular divergences in the time-dependent perturbation functions. The normalization terms are always important, although the formulation of a simple method for including them is of greatest utility in applications requiring higher-order perturbation theory (e.g., nonlinear optical phenomena), where difficulties have arisen in previous treatments. Although the Dirac perturbation technique includes the correct secular and normalization terms when properly executed, it is convenient to reinterpret the perturbation problem so that the secular and normalization terms can be factored from the wave function to all orders. It is shown that an appropriate overall multiplicative, time-dependent normalization and phase factor can be obtained, and that it is simply the amplitude for finding the system in the unperturbed eigenstate at any time t. The regular part of the wave function remaining after this factorization provides a complete description of the physical properties of the system of interest and determines the overall normalization and phase as well. Most important, the regular function and its perturbation expansion satisfy equations which are more convenient for computational applications than are the customary Dirac equations, and, in contrast to the latter, they reduce directly to the familiar time-independent perturbation equations in the static limit. To illustrate the general development, the model problem of a linearly perturbed harmonic oscillator and the static, harmonic, and electromagnetic perturbations of arbitrary quantum-mechanical systems are treated explicitly. In the case of an adiabatically applied static perturbation, the familiar adiabatic theorem is recovered with the overall phase factor giving the perturbed eigenvalue, while in the case of an harmonic perturbation, the overall phase factor obtained includes the system level shift appropriate for a quasiperiodic state. For an electromagnetic perturbation, compact expressions are obtained for various nonlinear optical susceptibilities in forms suitable for computations. Time-dependent Hartree–Fock approximations are treated explicitly to demonstrate that difficulties can arise when normalization and secular terms are not extracted prior to application of the perturbation formalism. Connection is also made with other methods which can be employed to eliminate secular and normalization terms from the wave function; these include a projection procedure and multiple-time-scales perturbation theory. The elimination of secular divergences from the perturbation functions is shown to be important for the construction of a valid Fourier transform. Secular and normalization terms also arise in connection with variational principles for the time-dependent Schrödinger equation. By employing the Frenkel variational principle and an ansatz for the total wave function that explicitly isolates the secular and normalization terms, a computationally convenient variational functional is obtained. This form of the Frenkel principle provides a bound to the system level shift induced by an oscillatory perturbation and is equivalent to the Ritz variational principle in the static limit. Explicit expressions for the variational functional in the Hartree–Fock approximations are derived in forms suitable for computational applications to the interactions of radiation and matter. (auth)

55074 APPROXIMATE METHODS FOR SOLVING SCHROEDINGER EQUATIONS WITH A SINGULAR POTENTIAL. Gogokhiya, V. Sh.; Filippov, A. T. (Joint Inst. for Nuclear Re-

search, Dubna, USSR). Yadern. Fiz.; 15: No. 6, 1294-1306(Jun 1972). (In Russian).

The theory of renormalizing the Schroedinger equations with a singular (at $r \to 0$) potential is briefly reported. It is shown, that singular potentials are quite naturally divided into renormalizable and nonrenormalizable ones, in this the structure of the series of usual perturbation theory (with cutoff at small distances) is similar to the corresponding one in renormalizable and nonrenormalizable field theories. Approximate methods for Schroedinger equations with the singular potential $g_0V(r)$, that allow to find the wave function and scattering amplitude in the form of a series in $g_0^{\nu}(\ln g_0)^{n_\nu}$, where n_ν is an integer and ν, in a general case, is a noninteger (a modified series of perturbation theory), are suggested. (auth)

55075 EXCITATION OF A TWO-LEVEL SYSTEM DAMPED BY THE INTERACTION WITH BOSONS. III. TRANSVERSE SUSCEPTIBILITY. Loos, J. (Inst. of Solid State Physics, Prague). Czech. J. Phys.; 22: No. 7, 583-8(1972).

The method developed in the preceding paper is used to determine the mean transverse spin components of a magnetic two-level system. Likewise as previously, the excitation by the monochromatic elliptically polarized hf field and the damping by the interaction with certain boson field is considered. No assumption is made concerning the strength of the hf field and therefore, this solution is valid in the saturation region too. The comparison with the solution of the macroscopic equations of motion is made. (auth)

55076 EXCITATION OF A TWO-LEVEL SYSTEM DAMPED BY THE INTERACTION WITH BOSONS. II. STATIONARY POPULATIONS. Loos, J. (Inst. of Solid State Physics, Prague). Czech. J. Phys.; 22: No. 6, 523-9(1972).

A two-level system excited by a monochromatic h.f. field and damped by an interaction with certain boson field is considered. The aim is to derive the steady-state level populations. The behavior of the system considered between two boson transitions is described by the quantum mechanical solution found in the preceding paper. The stationary populations are deduced by averaging the corresponding quantum mechanical probabilities with respect to the initial conditions. (auth)

55077 SPIN-DEPENDENT OPERATORS IN THE OCCUPATION-BRANCHING NUMBER REPRESENTATION. Gouyet, J. F. (Ecole Polytechnique, Paris). J. Math. Phys. (N. Y.); 13: No. 5, 745-51(May 1972).

In two preceding papers, a general method was given of building up open-shell wavefunctions which are eigenfunctions of the spin operators S^2. This method leads to a second quantization type formalism, where degenerate multiplets are described in what we call the occupation-branching number representation. In Paper II, equivalent monoelectronic and bielectronic operators were defined and a diagrammatic technique was developed. In the present paper, the equivalent spin-dependent operators in the occupation-branching number representation are built up, in the cases of monoelectronic and bielectronic operators. The spin–orbit and the spin–spin coupling are the most important operators of this kind. The associated diagrammatic representation is given. (auth)

55078 CONTINUED-FRACTION METHOD FOR PERTURBATION THEORY. Scofield, D. F. (Aerospace Research Labs., Wright-Patterson AFB, Ohio). Phys. Rev. Lett.; 29: No. 12, 811-14(18 Sep 1972).

A direct operational approach to the solution of the Schrödinger equation has led to an iterative nonperturbative method for its solution. The method, when applied to the Mathieu equation and the anharmonic-oscillator equation, is superior to the perturbation-iteration method and to Rayleigh-Schrödinger perturbation theory both in terms of rate of convergence and range of coupling constant allowed. (auth)

55079 ANALYTIC EXTRAPOLATION FROM BOUNDARY AND INTERIOR POINTS. Nenciu, G. (Inst. of Atomic Physics, Bucharest). Lett. Nuovo Cim.; 4: No. 14, 681-4(5 Aug 1972).

The problem of the analytic extrapolation from boundary and interior points is considered in the framework of the functional-integration approach initiated by Cutkosky. (L.B.S.)

55080 NOTE ON FEYNMAN'S PATH INTEGRALS. Goovaerts, M. J.; Devreese, J. T. (Univ., Antwerp). Physica; 60: No. 1, 97-13(Jul 1972).

Path integrals are introduced using the properties of integral equations of the Fredholm type. This framework seems well adapted for studying the equivalence between the path-integral formalism and other formulations of quantum mechanics, and for examining the relation between path integrals and expansions like the Born series. The study of these integral equations shows how a density matrix is related to a Stieltjes integral. In principle our study reduces the problem of calculating a path integral to a problem of traditional analysis. A series expansion of a transform of the path integral which was introduced recently is shown to satisfy Schroedinger's equation and to be also related to a Liouville-type iteration of an integral equation. The problem of oscillatory integrals in Feynman's formalism is also discussed. (auth)

REACTOR TECHNOLOGY

Power Reactor Development

Refer also to abstracts 53107 and 53191–53193.

55081 (AECL–4162) AECL ANNUAL REPORT, 1971–1972. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). 48p. Dep. NTIS (U. S. Sales Only).

The activities of the Atomic Energy of Canada Limited for the year ending March 31, 1972, are summarized. Highlights of developments in nuclear power, radiation and radioisotopes, heavy water production, and research are included. (H.D.R.)

55082 (EIR–215) MOLTEN CHLORIDES FAST BREEDER REACTOR PROBLEMS AND POSSIBILITIES. Taube, M.; Ligou, J. (Eidgenoessisches Institut fuer Reaktorforschung, Wuerenlingen (Switzerland)). Jun 1972. 75p. Dep. NTIS (U. S. Sales Only).

A fast breeder reactor of 2000 MW(t) output using molten chlorides as fuel and coolant is discussed. Some of the most significant characteristics are: the fuel contains only $PuCl_3/NaCl$; the coolant is $UCl_3/NaCl$ and also forms the fertile material along with the blanket, again $UCl_3/NaCl$; and the fuel circulates through the core by forced convection. The thermal stability of the reactor is very good. Power excursions of fuel temperature transients are quickly damped by the phenomena of fuel expansion pushing part of the fissile material out of the critical zone. The balance of fission products including free chlorine seems to be stabilized when some of the semi-noble metals (Ru, Rh, Pd and some Mo) are present in the elementary form. Corrosion effects form the most difficult problem. Thermodynamic studies suggest the use of molybdenum alloys as structural materials. Separation of the fuel component from the fertile component UCl_3 helps to overcome some of the corrosion problems. A reprocessing system based on a salt-metal-transport process seems to be attractive from the point of view of the economics of the plant as a whole. The possibility of using a dissociating gas as a secondary working agent in the turbine for example Al_2Cl_6 and N_2O_4 is discussed. (auth)

55083 (EURFNR–1001) FAST REACTOR PROGRAMME. Fourth Quarter 1971 Progress Report. Hoekstra, E. K. (comp.) (Reactor Centrum Nederland, Petten). Mar 1972. 78p. (RCN–168). Dep. NTIS (U. S. Sales Only).

Work performed under United States–Euratom Fast Reactor Exchange Program.

The RCN programme comprises reactor physics, fuel irradiations, advanced fuels, radiation damage in canning materials, analysis of impurities in sodium, aerosol research and heat transfer and hydraulics. (9 references) (auth)

55084 (INIS-mf-212) ATOM 71. Progress Report, April 1, 1970–March 31, 1971. (United Kingdom Atomic Energy Authority, London (England)). 1971. 23p. INIS.

The nuclear power program undertaken by the UKAEA during 1970–71 is surveyed. The exploitation of the Authority's accumulated expertise and resources for the benefit of industry outside the nuclear power field by means of applied nuclear projects and also non-nuclear applications is presented. The aims of the fusion research program are considered. (U.K.)

55085 NEW ENERGY TECHNOLOGY: SOME FACTS AND ASSESSMENTS. Hottell, H. C.; Howard, J. B. Cambridge, Mass.; Massachusetts Institute of Technology Press (1971). 373p. $2.95.

Past, present, and future US energy production is summarized. Background for assessment of new energy technology is given. Fossil fuel-to-fuel conversion, nuclear power, central station power from fossil fuel, utilization related energy problems, and special energy conversion systems of secondary importance are discussed. (M.C.G.)

55086 OPTIONS IN POWER GENERATION AND TRANSMISSION. Baron, S. Pub. Util. Fortn.; 90: No. 2, 22-31(20 Jul 1972).

Possible alternatives in power generation and transmission available around 1980 and 1990 are discussed and generating costs compared with those for 1970. Topics covered include: fossil fuel costs and air pollution control, thermal effects, freshwater sources, seawater sources, dry towers, offshore sites, extra-high voltage with hydro or mine-mouth generation, fast-breeder reactors, high-temperature gas turbines, magnetohydrodynamics, fuel cells, and aesthetics. (M.C.G.)

55087 BRITAIN'S NUCLEAR OPTIONS. Kenward, Michael. New Sci.; 55: No. 809, 332-5(17 Aug 1972).

The economic and technical difficulties encountered by designers and engineers in the various programs for production of power with AGR, HTGR, LWR, SGHWR, and LMFBR are reviewed. Britains experience and possible future use of the various systems are discussed. The growth in electricity demand and methods whereby the CEGB could meet it are presented. (UK)

55088 OUTLOOK FOR NUCLEAR POWER GENERATION. Catchpole, S. (Central Electricity Generating Board, London). Chem. Ind. (London) No. 15, 592-7(5 Aug 1972).

Some of the most important factors determining the growth of nuclear power in the UK are discussed under the following headings: estimates of demand and plant requirements; future availability of competing fuels; availability of nuclear plant and future reactor choice. Uncertainties and conflicting requirements are emphasized. (UK)

55089 NUCLEAR POWER IN JAPAN. Greenhalgh, G. H. London; British Nuclear Forum (1971). 50p.

A report is presented based on a visit to Japan, May 19 to June 3, 1971, and on published information. The subject is covered in sections: the structure of the nuclear industry in Japan (the electrical utilities; the manufacturing industry; government organizations; Japan Atomic Industrial Forum; finance; the public; collaboration with overseas companies in U.S.A., France, Germany, and U.K.); reactor systems in Japan (light water reactors; the gas cooled reactor; the advanced thermal reactor; fast reactors; nuclear ships); the fuel cycle; Japanese nuclear power program. (UK)

55090 CONCEPTION ON NUCLEAR ENERGY TILL 2000 A.D. Data Compiled. Tokyo; Japan Atomic Industrial Forum, Inc. (1971). vp. (In Japanese).

Separate abstracts were prepared for each of 4 papers presented. (M.C.G.)

For abstracts of individual papers see: 55091–55094.

55091 FUTURE VIEW OF ECONOMIC SOCIETY AND ELECTRIC POWER DEMAND. pp 1-18 of Conception on Nuclear Energy Till 2000 A.D. Tokyo; Japan Atomic Industrial Forum, Inc. (1971). (In Japanese).

Adjustment and renovation in the 1970s, de-industrialization in the 1980s, and higher internationalization in the 1990s are predicted. The growth rate will slow under the action of restricting factors in the 1980s and the growth rate will slow to 4 to 5% in the 1990s. Features of the industrial structure in each period are predicted. Expansion of petroleum demand will continue but the demand structure will change due to pollution countermeasures. The development of nuclear energy is predicted as necessary for production of electricity. In the 2000s, the total energy demand converted to petroleum is predicted as 1800 million kl, and its composition will be 56% for industries, 15% for transport, 25% for people's livelihood, and 4% for other. Electricity consumption for one home will be 8000 kWh in the 1980s and 15000 kWh in the 1990s. Total electric power demand will be 2400 billion kWh in 2000s. Its composition will be 26% for lighting, 14.2% for service, 57.4% for industries, and 2.4% for electric vehicles. (Japan)

55092 EXAMINATION OF SCALE OF DEVELOPMENT FOR NUCLEAR POWER GENERATION. pp 21-48 of Conception on Nuclear Energy Till 2000 A.D. Tokyo; Japan Atomic Industrial Forum, Inc. (1971). (In Japanese).

To meet power demand, power generation facilities of nine electric power companies will be 169 million kW in 1980, 286 million kW in 1990, and 440 million kW in 2000. In Japan, most of the primary energy resources depend on oversea countries. Therefore more emphasis may be placed on nuclear power generation in Japan. Maximum effort must be exerted to reduce the sulfur content of oil and this affects fuel cost adversely. On the other hand, the cost of nuclear fuel may be lowered by improvement of fuel design, expansion of fuel cycle industries, and effect of mass production. The fuel cost for 1 million kW LWRs is estimated as 0.56 to 0.68 yen/kWh. Most economically usable hydraulic power has been developed already, and only pumping-up power plants will be developed in the future. Lands suitable for the location of nuclear power plants were surveyed in 1967, and most of them are in northern Japan. Construction cost and power generation cost of the nuclear power plants were estimated and compared with those of thermal power plants. The scale of development of nuclear power generation will be 27, 110, and 220 million kW in 1980, 1990, and 2000, respectively, in view of economy. These

values are equivalent to 16, 39, and 50% of the total power generation in each year. (Japan)

55093 DATA FOR CALCULATING VALUES ON NUCLEAR FUEL CYCLES. pp 51-75 of Conception on Nuclear Energy Till 2000 A.D. Tokyo; Japan Atomic Industrial Forum, Inc. (1971). (In Japanese).

It was assumed that the scale of nuclear power generation will be 27 million kW in 1980, 110 million kW in 1990, and 220 million kW in 2000. Types of reactors examined were PWRs, BWRs, AGRs, ATRs, HTGRs, and FBRs. Basic combination pattern of the reactors is LWRs + FBRs and LWRs + ATRs + FBRs. Unit capacity will be 1.5 million kW for LWRs and 1 million kW for ATRs and FBRs. The ATRs will start operation from 1981 and the FBRs from 1986. SIRIUS-NIP-A, FULAM-4 and -5, MITIEN, and NURAN-3 codes were employed for the calculations, and the results were compared and examined. The required amount of U_3O_8 is 8000 to 9000 ST in 1980, 16000 to 21000 ST in 1990, and 15000 to 20000 ST in 2000 according to the proportion of employment of the ATRs. The required amount of enrichment is 4000 to 5000 MT SWU in 1980, 8000 to 14000 MT in 1990, and 9000 to 15000 MT in 2000. The required amount of forming and fabrication is 1200 to 1400 MT U in 1980, 3200 to 4500 MT in 1990, and 3300 to 4900 MT in 2000. The amount of reprocessing is 500 MT U in 1980, 2000 to 3300 MT in 1990, and 3500 to 5100 MT in 2000. The amount of fissionable plutonium is 7 MT in 1980, –3 to 50 MT in 1990, and –180 to 65 MT in 2000. Finally, the required amount of heavy water is 0 MT in 1980, 0 to 1500 MT in 1990, and 0 to 200 MT in 2000. (Japan)

55094 FUTURE VIEW OF INDUSTRIES SUPPLIED WITH ATOMIC ENERGY. pp 79-111 of Conception on Nuclear Energy Till 2000 A.D. Tokyo; Japan Atomic Industrial Forum, Inc. (1971). (In Japanese).

The nuclear energy supply industry supplies equipments, material, fuel, and service proper to nuclear energy in various fields of peaceful uses, such as nuclear power generation, nuclear ships, multipurpose utilization of reactors, and use of radioisotopes and radiation. Investment, turnover, number of employees, and results of introduction of foreign techniques show slow but steady development of the industry. In 1969, the investment was 1,103 million yen, the turnover was 71,475 million yen, and 8,264 engineers, researchers, clerks, and workers were employed. In Japan, engineering for nuclear plants is carried out by the plant makers, and the proportion of domestically produced machinery and equipments increases gradually. Domestic production of uranium fuel was 29,706 kg U in 1971. Major export of machinery for nuclear power generation was 4 pressure vessels, 2 containment vessels, 1 set of turbine and generator, and 5 sets of LP section and LP rotor of turbine. Development of the nuclear power generation in the world was surveyed for the purpose of examining export prospects. Expected domestic demand for reactors will be 11 million kW in 1990 and 16 million kW in 2000, and that for turbines and generators will be 16 million kW in 1990, and 25 million kW in 2000. Annual production capacity for nuclear fuel in 1980, 1990, and 2000 is estimated for LWR and FBR plants and for LWR, ATR, and FBR plants. (Japan)

55095 TENDENCIES IN THE DEVELOPMENT OF FAST BREEDER REACTORS. Haefele, W. (Kernforschungszentrum, Karlsruhe, Ger.). Atomwirt. Atomtech.; 17: No. 7, 378-84 (Jul 1972). (In German).

The German-Benelux project SNR 300, together with the corresponding British and French projects, can be considered as part of a dynamic European fast breeder development. The French and British projects, however, will become operational several years earlier than SNR 300. As an advantage, the initial design of the SNR already took into account all aspects for development of future commercial breeder power plants. Further coordinated development should be centered around extensive irradiation experiments for optimizing burnup, need for a special large test reactor, safety experiments, and efforts to achieve initially low fabrication costs for plutonium fuel elements. (tr-auth)

55096 PROTOTYPE NUCLEAR POWER PLANT SNR 300. Brandstetter, A.; Guthmann, E. (INTERATOM, Bensberg, Ger.). Atomwirt. Atomtech.; 17: No. 7, 368-71(Jul 1972). (In German).

The SNR 300 is described with respect to system groups of the installation such as reactor, fuel element handling and storage, sodium heat exchanger, support systems, steam power system, and electrotechnical installations. Also described are the total layout and the buildings. The reactor building consists of the internal and external containment with rectangular floor plan. The primary system is designed according to the loop concept in which tubings connect the separately placed reactor vessel, pumps, and heat exchanger. The concept permits more freedom with respect to layout of the plant and placement of shielding. In addition, the components are more easily accessible and the prototype permits easier extrapolation to large-scale unit. (tr-auth)

55097 ORGANIZATION AND ECONOMIC SIGNIFICANCE OF BREEDER DEVELOPMENT. Scheuten, G. H. (Schnell-Brueter-Kernkraftwerksgesellschaft mbH, Essen). Atomwirt. Atomtech.; 17: No. 7, 366-8(Jul 1972). (In German).

The SNR 300, representing a joint German–Benelux project, is only an introductory step toward development of commercial fast breeders, which must be coordinated internationally to an even higher degree. Only when economic competitiveness is achieved will breeders exert their great advantages with respect to fuel supply, high efficiency, and decreased environmental hazards. Expenses for breeder development appear justified as a solution to future energy problems. Discussed are preparatory work and present status of the SNR 300 project, enlargement of international cooperation, and economic significance of fast breeder development. (H.B.G.)

55098 PROJECT SNR: GOVERNMENTAL SUPPORT AND INTERNATIONAL COOPERATION. Daeunert, U.; Schmidt-Kuester, W. J. (Bundesministerium fuer Bildung und Wissenschaft, Bonn). Atomwirt. Atomtech.; 17: No. 7, 363-6(Jul 1972). (In German).

Development of fast breeders belongs to the large-scale projects which transcend not only the capabilities of private industry but also of single nations. Therefore, in the BRD, the development is undertaken with governmental support as an international project together with the Benelux countries. In the spring of 1972, the first decisive phase of the project SNR 300 was concluded with government agreements, a letter of intent, and the designation of an upper price limit. Projected is construction of a 280 MW(e) prototype nuclear power plant with a sodium-cooled fast breeder reactor (SNR 300) at Kalkar on the lower Rhine River. (H.B.G.)

Physics and Core Engineering

Refer also to abstract 55398.

55099 (AD-738874) SOLUTION OF A NUCLEAR-REACTOR PARAMETER-IDENTIFICATION PROBLEM. Canepa, Oscar Eduardo Brain (Naval Postgraduate School, Monterey, Calif.). Jun 1971. 87p. NTIS.

Thesis.

A continuous identification of parameters is performed on a simulated fast breeder nuclear reactor system using hybrid computation and applying techniques of statistical regression analysis and exponentially-mapped-past functions. Output states which are not directly measurable are estimated by use of a Kalman filter. The method developed in this study is applied to a numerical example which demonstrates that unknown parameters can be identified within 3% of their actual value, with signal noise ratios as low as 10 : 1 in the measured states. The example also demonstrates that convergence occurs in a reasonably short time. (auth)

55100 (BARC/I-148) PHYSICS DESIGN OF HEAVY WATER MODERATED REACTORS. Srinivasan, K. R. (Bhabha Atomic Research Centre, Bombay (India)). 1971. 215p. INIS.

A collection of lectures given at a course arranged at the Bhabha Atomic Research Centre, Bombay, for theoretical physicists to familiarize them with physics aspects and design characteristics of heavy water moderated reactors is presented. The conventional method using the four factor formula is discussed for calculating lattice parameters and long term reactivity change. Some aspects of fuel management are covered. The reactor theory underlying the calculational methods is described in detail. (INIS)

55101 (CISE-R-203) EXPERIMENTAL INVESTIGATIONS ON U–D_2O LATTICES. Accinni, F.; Mangialajo, M.; Taddei, F. (Centro Informazioni Studi Esperienze, Milan (Italy)); Ciuffolotti, L. (Societa Ricerche Impianti Nucleari, Saluggia (Italy)). Dec 1967. 53p. (In Italian). INIS.

Experimental investigations on D_2O-moderated natural uranium fueled lattices have been carried out. The experimental parameters δ^{28}, ρ^{28}, ICR, intracell neutron density distribution and spectral indices were determined. The results are presented with some comments on the precision and the interpretation of measurements. (INIS)

55102 (CISE-R-239) PRELIMINARY REPORT ON THE MEASUREMENT OF CELL PARAMETERS IN THE RB-1 REACTOR. Accinni, F.; Mangialajo, M. (Centro Informazioni Studi Esperienze, Milan (Italy)); Baccolini, A.; Casali, F.; Corberi, A.; Zappellini, G. (Comitato Nazionale per l'Energia Nucleare, Bologna (Italy). Centro di Calcolo); Ciuffolotti, L. (Societa Ricerche

Impianti Nucleari, Saluggia (Italy)). Jan 1968. 56p. (In Italian). INIS.

Experiments carried out in RB-1 Reactor of Montecuccolino (Bologna) in the framework of CIRENE Program, for UO_2/D_2O lattices are described. The work done in preparation for these experiments is also illustrated. (INIS)

55103 (CISE-R-242) MOICANO-1 CODE FOR REACTIVITY AND TWO-GROUP FLUX CALCULATION OF A FOG-COOLED REACTOR, TAKING INTO ACCOUNT THE TRUE COOLANT DISTRIBUTION AND THE EQUILIBRIUM XENON POISONING. Bruschi, C.; Foresti, G.; Pierini, G.; Rubbia, S. (Centro Informazioni Studi Esperienze, Milan (Italy)). Nov 1967. 19p. INIS.

The Moicano-1 code is described, which provides a rapid tool for survey calculation of CIRENE-type reactors, once material composition and geometrical configuration have been given. The basic features of the core are: a two-group energy treatment of neutron flux, which is spatially used in the approximate monoseparable form; a simplified calculation of the coupling between thermal power and coolant density, which is strongly dependent on the axial coordinate along the power channel; the power level fixed by limiting the power in any point of the reactor core, which has never exceeded a fixed value (given as an input to the code). The FORTRAN IV version of the code exhibits a running time of about 4 minutes on the IBM-7040 computer. (INIS)

55104 (CISE-R-246) TERMO: DIGITAL CODE TO EVALUATE THE STEADY STATE PARAMETERS OF A CIRENE TYPE REACTOR. Goldaniga, G.; Grassi, G. P.; Muscettola, M.; Pedrocchi, F. (Centro Informazioni Studi Esperienze, Milan (Italy)). Oct 1967. 65p. (In Italian). INIS.

The digital program TERMO is presented which has been set up to compute the stationary thermohydraulic parameters of a CIRENE-type reactor, as depending on preassigned geometry, power distribution, feedwater, enthalpy and plant pressure. (INIS)

55105 (CISE-R-258) NEUTRON MEASUREMENTS AT ZERO POWER ON A CIRENE FUEL ELEMENT IN THE ESSOR REACTOR. Accinni, F.; Mangialajo, M.; Morandi, G.; Morselli, M. (Centro Informazioni Studi Esperienze, Milan (Italy)). Dec 1967. 13p. (In Italian). INIS.

Results on neutron physics measurements performed at zero power on a CIRENE fuel element in the ESSOR reactor — Ispra Center — are reported. These experiments were carried out, in the framework of CART plant achievement, in order to obtain an experimental examination of the flux situation to which the CIRENE element will be exposed during the irradiation program for which the CART plant was built. (INIS)

55106 (CISE-R-283) BUCKLING MEASUREMENTS IN ECO WITH FEW CIRENE FUEL ELEMENTS. Accinni, F.; Mangialajo, M.; Taddei, F. (Centro Informazioni Studi Esperienze, Milan (Italy)); Casini, G.; Hettinger, H.; Hohmann, H.; Paillon, M.; Toselli, F. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). Oct 1968. 21p. INIS.

Buckling measurements for UO_2/D_2O lattice configurations considered in the framework of the CIRENE project have been performed in the ECO reactor at Ispra. The experimental results and their analysis with homogeneous and heterogeneous (source-sink) methods are presented. (INIS)

55107 (CONF-720901-(Bks.1 and 2), pp 3-22) PHYSICS OF PWR REACTORS. Hellens, R. L. (Combustion Engineering, Inc., Windsor, Conn.). 1972.

From Meeting on new developments in reactor physics and shielding calculations; Kiamesha Lake, NY. (12 Sep 1972).

The physics of pressurized water reactors is reviewed. The main emphasis is placed on some observations drawn from core design and plant follow experience. The degree of success in explaining reactor physics data taken from four operating reactors that have had active measurement programs is discussed. 15 references. (auth)

55108 (CONF-720901-(Bks.1 and 2), pp 23-32) PHYSICS OF GAS COOLED REACTORS. Dahlberg, Richard C. (Gulf General Atomic Co., San Diego, Calif.). 1972.

From Meeting on new developments in reactor physics and shielding calculations; Kiamesha Lake, NY. (12 Sep 1972).

The temperature coefficient of the HTGR is composed of a strong negative Doppler coefficient and a positive moderator coefficient, the net effect being about -10×10^{-5}/°C at room temperature and -2×10^{-5}/°C at operating temperature. The positive moderator coefficient is a result of the absence of significant density coefficients and the nuclear characteristics of ^{233}U. In addition, selected fission products, principally ^{135}Xe, contribute positive components to the temperature coefficient. Current estimates of the value of the temperature coefficient in the HTGR are presented along with recent experimental data pertinent to the subject. 11 references. (auth)

55109 (CONF-720901-(Bks.1 and 2), pp 33-54) PHYSICS OF HIGH TEMPERATURE REACTORS AT THE COMMISSARIAT A L'ENERGIE ATOMIQUE. Laponche, B. (CEN, Saclay, France); Morier, F. 1972.

From Meeting on new developments in reactor physics and shielding calculations; Kiamesha Lake, NY. (12 Sep 1972).

The experimental program on High Temperature Reactor Physics achieved at the Commissariat à l'Energie Atomique is presented. The main studies are based on the low enriched uranium cycle and the tubular interacting fuel element. A first phase, already completed, deals with buckling, k_∞, and reaction rate measurements, in MARIUS, at room temperature: buckling was measured by flux mapping and progressive replacement on a 3.5% enriched UO_2 particulate fuel lattice; k_∞ was measured by the null reactivity method (PCTR technique) on a 1% enriched UO_2 particulate fuel lattice; spectrum indices and relative conversion ratio were also measured in both lattices. Data analysis was performed using the APOLLO code, as part of a general comparison between calculation and experiment covering a variety of uranium fuel types and the three main moderators. The conclusions of this study are also given. A second phase of experimentation (1973) deals with temperature coefficient measurement in CESAR (from 20 to 450°C) on the same lattice and oscillation measurement of UO_2-PuO_2 particulate samples. A third phase, part of a tri-partitate program (UKAEA-DRAGON Project-CEA) is based on irradiated fuel studies: chemical and isotopic analysis of fuels irradiated in the DRAGON Reactor and oscillation of irradiated samples. In cooperation with KFA Jülich, a critical experiment took place in CESAR in 1972. Fluxes, reaction rates and control rod worth were measured at room temperature in a central zone of the reactor, loaded with balls (3.5% enriched UO_2 particulate fuel). 16 references. (auth)

55110 (CONF-720901-(Bks.1 and 2), pp 55-67) SOME PROBLEMS IN THE PHYSICS OF HIGH TEMPERATURE REACTORS. Tyror, J. G.; Askew, J. R.; Johnstone, I. (Atomic Energy Establishment, Winfrith, Eng.). 1972.

From Meeting on new developments in reactor physics and shielding calculations; Kiamesha Lake, NY. (12 Sep 1972).

To meet the accuracies required for design calculations on HTR systems, rather detailed theoretical models have been developed and validated by comparison with the results of an extensive program of specially designed experiments. The general philosophy is illustrated for 2 problem areas: resonance capture in granular fuel and within-block power distribution. While some problems still remain in the areas so far studied, the confirmation of the reactivity time predictions at high irradiation is identified as the most significant outstanding question. 14 references. (auth)

55111 (CONF-720901-(Bks.1 and 2), pp 68-80) METHODS FOR THREE-DIMENSIONAL FUEL MANAGEMENT STUDIES ON HIGH TEMPERATURE REACTORS. Askew, J. R.; Anderson, D. W.; Pearson, K. G. (Atomic Energy Establishment, Winfrith, Eng.). 1972.

From Meeting on new developments in reactor physics and shielding calculations; Kiamesha Lake, NY. (12 Sep 1972).

Methods for studying fuel management in high temperature reactors have been developed in the U.K. by extending techniques already applied to the earlier AGR systems. The more severe modelling problems of the new system have demanded innovations to retain the desired accuracy, and improved coarse mesh finite difference algorithms, spectrum models for data condensation to few groups and novel iterative strategies for solving for control rod positions are described. Together they give a rapid 3-dimensional power solution of acceptable accuracy. (auth)

55112 (CONF-720901-(Bks.1 and 2), pp 114-40) PHYSICS OF BWR's. Crowther, R. L. 1972.

From Meeting on new developments in reactor physics and shielding calculations; Kiamesha Lake, NY. (12 Sep 1972).

The status of the physics of BWR's is summarized with emphasis on new developments and information gained from operating power reactors. 18 references. (auth)

55113 (CONF-720901-(Bks.1 and 2), pp 211-28) STUDIES OF METHODS FOR FAST NEUTRON MULTIGROUP CROSS SECTION GENERATION AND THEIR EFFECT UPON THE NEUTRONICS PROPERTIES OF LMFBR CRITICAL ASSEMBLIES. Stacey, W. M. Jr.; Henryson II, H.; Zolotar, B. A.; Hwang, R. N.; Toppel, B. J.; Stenberg, C. G.; Pennington, E. M. (Argonne National Lab., Ill.). 1972.

From Meeting on new developments in reactor physics and shielding calculations; Kiamesha Lake, NY. (12 Sep 1972).

The sensitivity of the integral neutronics properties of several

LMFBR critical assemblies to multigroup cross section generation methods is investigated with particular emphasis upon comparison of newly developed and routinely used methods. These studies include resonance algorithms, use of an intermediate group library, the effect of spatial nonuniformity, use of consistent B_1 or inconsistent P_1 formulations, and the use of different fine-group structures in the averaging of ultrafine group constants. 12 references. (auth)

55114 (CONF-720901–(Bks.1 and 2), pp 724-38) GE NUCLEAR DESIGN AND BENCHMARK CRITICAL EXPERIMENT PLAN FOR THE LMFBR DEMONSTRATION PLANT. Bailey, H. S.; Stewart, S. L. (General Electric Co., Sunnyvale, Calif.). 1972.

From Meeting on new developments in reactor physics and shielding calculations; Kiamesha Lake, NY. (12 Sep 1972).

The background planning related to the General Electric LMFBR Demonstration Plant design that provides the basis for the configuration and experiments planned for ZPPR-3 is presented. The specified experimental configurations and plans are summarized and some details of the experimental plan for each of the phases are presented. (auth)

55115 (CONF-720901–(Bks.1 and 2), pp 771-88) REVIEW OF FBR PHYSICS. Avery, R. (Argonne National Lab., Ill.). 1972.

From Meeting on new developments in reactor physics and shielding calculations; Kiamesha Lake, NY. (12 Sep 1972).

A qualitative review is made of FBR physics in which primary focus is put on the physics problems facing the fast reactor designer with particular emphasis on current outstanding problems. Some of the problems considered include the central worth discrepancy, Doppler and sodium coefficients, control rod effects, and long term effects related to the fuel cycle. Also discussed is the role and status of the critical experiment program in supplying a base of integral data on large dilute plutonium systems as well as providing specific information on the above items and others. The role and status of differential cross section knowledge is discussed relative to fast reactor needs with emphasis being given to the significant uncertainties that still exist in some of the primary fissile and fertile isotope cross sections. The status of some of the major code development activities in the areas of cross section processing, neutron diffusion, and space-dependent kinetics is discussed relative to fast reactor design needs. (auth)

55116 (CONF-720901–(Bks.1 and 2), pp 789-808) DEMONSTRATION REACTOR BENCHMARK PROGRAM. Davey, W. G. 1972.

From Meeting on new developments in reactor physics and shielding calculations; Kiamesha Lake, NY. (12 Sep 1972).

The critical studies comprising the benchmark program for the Liquid Metal Fast Breeder Reactor demonstration plant are described. The configurations examined and measurements performed on the Zero Power Plutonium Reactor and the ZPR-6 assemblies are discussed. (H.D.R.)

55117 (CONF-720901–(Bks.1 and 2), pp 809-21) SPATIALLY DEPENDENT BENCHMARK PARAMETERS IN THE INITIAL DEMONSTRATION PLANT CRITICAL ASSEMBLY. Amundson, P. I.; Davey, W. G.; Palmer, R. G.; (and others). 1972.

From Meeting on new developments in reactor physics and shielding calculations; Kiamesha Lake, NY. (12 Sep 1972).

The features of the Zero Power Plutonium Reactor Assembly 2 are described. The use of this assembly in benchmark measurements of Liquid Metal Fast Breeder Reactor physics parameters is discussed. (H.D.R.)

55118 (CONF-720901–(Bks.1 and 2), pp 822-38) REACTOR PHYSICS AND FAST POWER BREEDERS: MASURCA CORE R-Z PROGRAM. Barre, J. Y.; Boyer, J.; Mougniot, J. C.; Sicard, B. 1972.

From Meeting on new developments in reactor physics and shielding calculations; Kiamesha Lake, NY. (12 Sep 1972).

The directions of the current CEA program of fast reactor physics are described, focusing on the MASURCA fast critical facility studies. These experiments concern mainly relative variation versus enrichment of characteristics of lattices fuelled either with plutonium (cores Z) or uranium (cores R) with the same diluent. The major results obtained for asymptotic mode neutron balance parameters (material buckling and spectral indices) and for engineering parameters (power distributions, blankets and control rods) are compared with an analysis made using CADARACHE reference data. Conclusions drawn from this analysis are then applied to the main PHENIX predicted parameters. 9 references. (auth)

55119 (CONF-720901–(Bks.1 and 2), pp 888-904) EXPERIMENTAL STUDY OF BURN-UP IN FAST BREEDER REACTORS. Bouchard, J. (CEN, Fontenay-aux-Roses, France); Chavardes, D.; Darrouzet, M.; Gourdon, J.; Robin, M. 1972.

From Meeting on new developments in reactor physics and shielding calculations; Kiamesha Lake, NY. (12 Sep 1972).

Fuel burnup studies using the RAPSODIE reactor are described. These studies include: (1) Determination of burnup. (2) Changes in the core composition, or more precisely in the fuel composition in the part of the core where the neutron distribution is in equilibrium. (3) Changes in the breeding blanket composition. (H.D.R.)

55120 (CONF-720901–(Bks.1 and 2), pp 905-27) EBR-II IRRADIATION PHYSICS. Meneghetti, D.; Loewenstein, W. B. (Argonne National Lab., Ill.). 1972.

From Meeting on new developments in reactor physics and shielding calculations; Kiamesha Lake, NY. (12 Sep 1972).

The use of EBR-II as a fast fuel irradiation facility illustrates its versatility for physics measurements. Its potentials are unique relative to those of the zero-power criticals especially in those areas where at-power conditions are important. For example, power reactivity components, gamma deposition, deep penetration of neutrons and gammas, feedback components, burnup, fission-product productions, and interaction problems of neutronics, gamma, coolant flow, and heat transfer. 35 references. (auth)

55121 (CONF-720901–(Bks.1 and 2), pp 928-39) SIGNIFICANCE OF INTEGRAL PARAMETERS IN THE DESIGN AND PERFORMANCE OF FAST BREEDER REACTORS. Greebler, P.; Hutchins, B. A. 1972.

From Meeting on new developments in reactor physics and shielding calculations; Kiamesha Lake, NY. (12 Sep 1972).

The use of integral parameters from critical experiments in support of fast reactor design and operation is discussed. The incentives for additional integral experiments is examined. (H.D.R.)

55122 (CONF-720901–(Bks.1 and 2), pp 959-72) PROTON-RECOIL PROPORTIONAL COUNTER SPECTROMETRY FOR REACTOR SPECTRUM MEASUREMENTS. Verbinski, V. V.; Young, J. C.; Neill, J. M.; Gionvannini, R.; Houston, D. H. (Gulf Radiation Tech., San Diego, Calif.). 1972.

From Meeting on new developments in reactor physics and shielding calculations; Kiamesha Lake, NY. (12 Sep 1972).

The factors that limit the accuracy of a proton-recoil proportional counter in measuring neutron spectra in reactors are discussed in light of detector response measurements and associated calibrations, reactor spectrum measurements with two different counter geometries, unscrambling experience with several different approaches, and comparisons with calculations and time-of-flight measurements. A critical analysis of proton-recoil spectrometry is attempted in that the approximations and omissions of each method are pointed out and improvements in both method and counter design suggested. 16 references. (auth)

55123 (CONF-720901–(Bks.1 and 2), pp 986-1005) SEFOR: VERIFICATION OF THE DOPPLER TRANSIENT SHUTDOWN CAPABILITY OF LMFBR's. Freeman, D. D.; Greebler, P.; Noble, L. D.; Pflasterer, G. R. (General Electric Co., Sunnyvale, Calif.). 1972.

From Meeting on new developments in reactor physics and shielding calculations; Kiamesha Lake, NY. (12 Sep 1972).

The SEFOR experimental program was undertaken to demonstrate and to measure the Doppler reactivity feedback in neutron spectra and at fuel temperatures and crystalline states representative of an operating LMFBR. Tests involving both static power reactivity measurements and rapid super-prompt-critical reactivity insertion from power (up to 1.3$ in 0.1 sec.) gave good agreement for the Doppler constant (Tdk/dT) in each of two cores. The first core contained six volume per cent BeO and gave a Doppler constant, Tdk/dT of $-.0081$. In the second core, in which the BeO was replaced by stainless steel to harden the neutron spectrum, a Doppler constant, Tdk/dT, of $-.0060$ was obtained. The overall experimental uncertainty on Tdk/dT is estimated to be ±10%, exclusive of uncertainties in delayed neutron parameters. Normalization of Doppler calculations to the SEFOR results can provide significant reductions in the uncertainty in transient power and energy calculations of interest in LMFBR accident analysis. A major achievement of the SEFOR experimental program was the successful completion of the super prompt transient tests. They give convincing confirmation of the soundness of the Doppler theory being applied to LMFBR's and demonstrate the inherent safety and stability of this type of reactor. In addition, the good agreement between pre-experiment analysis and experimental results points up the predictable transient neutronics behavior of oxide fueled LMFBR's. 11 references. (auth)

55124 (CONF-720901-(Bks.1 and 2), pp 1016-32) PULSED-ACTIVATION TECHNIQUES FOR THE MEASUREMENT OF DOPPLER EFFECTS. Foell, W. K.; Russell, G. J.; Lucoff, D. M.; Bhattacharyya, S. K. (Univ. of Wisconsin, Madison). 1972.

From Meeting on new developments in reactor physics and shielding calculations; Kiamesha Lake, NY. (12 Sep 1972).

The pulsed activation Doppler (PAD) technique offers an experimental approach appropriate for the measurement of Doppler effects at high temperatures. The experimental methods, data handling techniques, and methods of interpretation presented gave satisfactory results when applied to uranium metal and UO_2 pellets at low and medium energy depositions, but appear to require some improvements for very high energy depositions. Specifically, it is necessary to determine the relative thermal flux depression more accurately in pellets of high enrichment. A feasibility study was carried out for the extension of the PAD technique to fast spectra. SEFOR was used as the model spectra for this study. The SEFOR transient time-shape function was used in computer calculations to obtain the time-dependent energy deposition and the resulting time-dependent temperature rise for PAD samples. At these temperatures and at each time step, self-shielded cross sections were calculated and then integrated with the fluence to yield a Doppler ratio. The results indicate that high effective temperatures could be achieved in PAD measurements with pellets having enrichments slightly higher than nominal LMFBR values. 17 references. (auth)

55125 (CONF-720901-(Bks.1 and 2), pp 1033-47) BENCHMARK TESTING OF NUCLEAR DATA FOR FAST REACTORS. Alter, Harry (Atomics International, Canoga Park, Calif.). 1972.

From Meeting on new developments in reactor physics and shielding calculations; Kiamesha Lake, NY. (12 Sep 1972).

Integral parameters for a series of fast reactor benchmark assemblies, covering a wide range of energy spectra, were calculated with the reference cross section set ENDF/B-3. Multigroup constants relative to each assembly were generated and used in S_n transport and/or diffusion theory calculations to obtain the parameters. The calculated parameters include k_{eff}, spectral indices (activation ratios), and central reactivity worths. Results of the several calculations indicate a significant improvement in the cross section data of the version 3 reference set over that contained in ENDF/B-2. (auth)

55126 (KFK-1577) ANISOTROPIC DIFFUSION IN GAS COOLED FAST BREEDER REACTOR. Eisemann, E. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). Mar 1972. 146p. (In German). Dep. NTIS (U. S. Sales Only).

The calculation of anisotropic diffusion effects (streaming effects) in gas cooled fast reactor lattices is presented. For this purpose, expressions have been derived for the components of a homogenized direction dependent cell diffusion coefficient. This was done in a multi-group formalism taking into account the anisotropy of the elastic scattering cross sections up to the first moment. Expressions for the components of the direction dependent diffusion coefficient have been developed which can be evaluated numerically. To demonstrate the influence of this diffusion coefficient calculations have been performed to determine the effective multiplication factor and the criticality change due to coolant variations for certain reactor concepts. 33 references. (auth)

55127 (KFK-1579) REST: PROGRAM FOR CALCULATION OF FISSION PRODUCT ACTIVITY AND DECAY CONSTANT AFTER VARIABLE REACTOR HISTORY IN TWO COUPLED SYSTEMS WITH RESPECT TO FISSION PRODUCT EMISSION. Waibel, E. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Reaktorentwicklung). Apr 1972. 38p. (In German). Dep. NTIS (U. S. Sales Only).

The FORTRAN programs REST 1, REST 2, and REST 3 were developed for the calculation of the fission product decay heat source within a nuclear reactor. REST 3 considers a distribution of the heat source by calculating fission product escape out of the fuel, as might be expected by accidental overheating of the core. The time dependency of the heat source within and outside the fuel is shown. A description and a user's guide for the programs is given. A BWR was used as a model for the calculations. 12 references. (auth)

55128 INSTALLATION FOR OBSERVING THE POSITION OF A STRUCTURE INSIDE A NUCLEAR REACTOR. Debergh, Philippe; Lagrange, Maurice (to Commissariat a l'Energie Atomique). French Patent 2,091,902. 21 Jan 1972. Filed 10 Apr 1970. (In French).

An installation for positioning the core-supporting structure of a reactor (e.g. sodium-cooled fast reactor) is presented. The installation consists of a closed tube containing an appropriately illuminated sighting system at one of its ends and a window at the other end. This tube, which is supported by the structure to be positioned, is elastically held in a fixed outer sheathing; an observation tube penetrates the sheathing from the other side; this tube is provided with a mirror system and a viewing telescope at its upper end. Any vertical displacement of the supporting structure is transmitted to the closed tube and any lateral displacement shifts the position of the tube in the sheathing. Both types of displacement can be observed through the telescope system. (France)

55129 FAST BREEDER REACTOR. Spenke, H. (to Siemens AG). German Patent 1,614,404. 17 Feb 1972. (In German).

A description is given of a technical way to decrease the coolant void coefficient by an appropriate design of the reactor core of steam-cooled or liquid-metal-cooled fast breeder reactors. The amount of fissionable fuel is decreasing within the cylindrically shaped reactor core in radial direction, as related to the axis of symmetry of the core. This decrease may be realized either steadily or in several stages. (GF)

55130 LIGHT-WATER BREEDER REACTOR. Beaudoin, Benoit R.; Cohen, Joseph D.; Jones, David H.; Marier, Lester J. Jr.; Raab, Harry F. (to United States Atomic Energy Commission). U. S. Patent 3,671,392. 20 Jun 1972. Filed 15 Mar 1971.

Described is a light-water-moderated and -cooled nuclear breeder reactor of the seed–blanket type characterized by core modules comprising loosely packed blanket zones enriched with fissile fuel and axial zoning in the seed and blanket regions within each core module. Reactivity control over lifetime is achieved by axial displacement of movable seed zones without the use of poison rods in the embodiment illustrated. The seed is further characterized by a hydrogen-to-uranium-233 atom ratio in the range 10 to 200 and a uranium-233-to-thorium-232 atom ratio ranging from 0.012 to 0.200. The seed occupies from 10 to 35 percent of the core volume in the form of one or more individual islands or annuli. (Official Gazette)

55131 REACTOR WITH SPHERICAL FUEL ELEMENTS. Ritz, H. L. (to Kernforschungszentrum). German Patent 1,302,274. 10 Feb 1972. (In German).

A description is given of configurations of spherical fuel elements, arranged in regular and uniform packings in such a manner that they will form an approximately spherical core. The purpose of this arrangement is to improve the coolant circulation in order to optimize the heat transfer and to obtain a nearly uniform temperature at all fuel elements. (GF)

Control and Instrumentation

55132 (ANL/EBR-63) DATA-PROCESSING SYSTEM FOR INSTRUMENT MAINTENANCE AND CALIBRATION AT EBR-II. Moriarty, K. J.; Ringquist, J. M. (Argonne National Lab., Ill. Argonne National Lab., Idaho Falls, Idaho). Jun 1972. Contract W-31-109-eng-38. 51p. Dep. NTIS.

Early in the operation of EBR-II, it was recognized that a computer program was required for the periodic calibration and maintenance of the more than 1600 instruments in service. Computer Program No. I, set up in 1964, evolved into Computer Program No. II by addition of updated scheduling, history cards, and a new computer to execute the program. Computer Program II, combined with the required procedures, has been operative for about one year. The operation of Computer Program II is described. (auth)

55133 (CISE-R-268) EXPERIMENTAL RESULTS ON THE OPERATION OF THE REACTIVITY FAST CONTROL SYSTEM OF THE CIRENE REACTOR. Marcandalli, R.; Possa, G. (Centro Informazioni Studi Esperienze, Milan (Italy)). May 1968. 43p. (In Italian). INIS.

The reactivity fast control system of the CIRENE reactor is envisioned to be accomplished by fluid rods: reactivity is varied through changes of a two-phase mixture of gas and poisoned light water flowing in separate tubes in the core. An out-of-pile experimental loop has been built at CISE for the hydraulic and dynamic tests. The results of the first complete set of measurements are presented and found to be in agreement with theoretical predictions. Minor modifications to the system are suggested. The hydraulic and dynamic performances match design specifications. (INIS)

55134 (CONF-720901-(Bks.1 and 2), pp 579-98) BORON AND TANTALUM CONTROL ROD STUDIES AND ABSOLUTE GAMMA RAY ABSORBED DOSES IN A LMFBR CRITICAL. Carpenter, S. G.; Simons, G. G.; Olson, A. P.; Goin, R. W.; Plummer, J. P. 1972.

From Meeting on new developments in reactor physics and shielding calculations; Kiamesha Lake, NY. (12 Sep 1972).

A set of measurements was taken on a typical LMFBR mockup (ZPPR Core 2) which provides data against which the components of control rod calculations can be compared for both B and Ta. The small sample control materials are in disagreement with the calculations in about the same amount as the fuel materials. The mockup rods calculations are actually closer to the measurement, which may indicate additional problems. The axial and radial distributions are well calculated. These distributions are not strong functions of rod size or poison material. The interactions between two rods separated by a typical distance are not large and are poorly calculated with diffusion theory. Absorbed gamma radiation dose distributions were measured with ^{7}LiF thermoluminescent dosimeters throughout Core 2. Deviations between calculation and experiment were found to exceed ±10% only at the outer limits of the reactor, where the absolute dose had fallen at least 2 orders of magnitude. For the central mockup control rod cases, the gamma radiation dose in B_4C and Ta was well calculated. 9 references. (auth)

55135 (DUN-SA-169) REDUCING THE EFFECT OF GROUNDS ON CRITICAL REACTOR CONTROL CIRCUITS. Neumayer, E. C. (Douglas United Nuclear, Inc., Richland, Wash.). 29 Jul 1971. 18p. Dep. NTIS.

The sensitivity of the ground detector may be increased as can the input resistance by increasing the resistance of the series resistors and selecting the proper meter sensitivity for them. Provisions for external annunciation and alarm may be utilized by using a meter-relay movement with adjustable alarm contacts. While the discussion deals with dc circuits, the principles can be applied to ac circuits also. (auth)

55136 (DUN-SA-186) APPLICATION OF COMPUTERS TO CONTROL AND MONITORING OF NUCLEAR REACTORS. Worster, L. D. (Douglas United Nuclear, Inc., Richland, Wash.). [nd]. 10p. Dep. NTIS.

A multi-channel system designed to satisfy the IEEE 279 Criteria For Nuclear Power Plant Protective Systems demonstrates how minicomputers dedicated to specific functions can satisfy the failure criteria and provide multiple data processing and control functions. The comprehensive data analysis capability of computers provides potential for power system performance improvement and cost reduction through application of computers in control and monitoring systems. (auth)

55137 (JAERI-Memo-3893) FLUX DISTRIBUTION MEASUREMENT NEAR STRONG ABSORBER USING VISTA METHOD. Takeuchi, Etji; Takeda, Renzo; Fukumura, Nobuo; Sakata, Hajime (Japan Atomic Energy Research Inst., Tokyo). Feb 1970. (In Japanese). NTIS (U. S. Sales Only).

Calculations on a cruciform control rod have been made as a part of the JP-II final design studies. Experiments were carried out using VISTA method. This method is an experimental physics technique, and by enlarging the system dimension, makes the phenomena easy to be observed. In the VISTA-SHE experiments, a boral absorber slab is substituted for the cruciformed control rod. The space dependency of the flux distribution, fine flux profile very near the absorber and the energy dependency of the neutron spectra were measured. Mn, Au, In and depleted uranium foils were activated with and without Cd cover. (auth)

55138 (ORNL-TM-729(Pt.2B)) MSRE DESIGN AND OPERATIONS REPORT. PART IIB. NUCLEAR AND PROCESS INSTRUMENTATION. Moore, R. L. (Oak Ridge National Lab., Tenn.). Sep 1972. Contract W-7405-eng-26. 439p. Dep. NTIS.

A detailed design is presented for the MSRE control systems, operating instrumentation, safety instrumentation, and circuitry. Included are layouts and schematic diagrams. (J.M.J.)

Containment Systems, Waste Processing, and Radiation Protection

Refer also to abstract 53061.

55139 (ANL-7911(Suppl.1)) COMPARISON OF A TWO-DIMENSIONAL HYDRODYNAMICS CODE (REXCO) TO EXCURSION EXPERIMENTS FOR FAST REACTOR CONTAINMENT. Ash, J. E.; Chang, Y. W.; Julke, R. T. (Argonne National Lab., Ill.). Jul 1972. Contract W-31-109-eng-38. 18p. Dep. NTIS.

The Reactor Excursion Containment Code System (REXCO) is a tool that was developed to predict the effects of excursions originating at the core upon the components and on the containment system of Liquid Metal Fast Breeder Reactors. The codes include hydrodynamic and inelastic material behavior depending on the magnitude of the excursion treated. The physical phenomena computed by the codes involve the shock wave, the sodium momentum, and the early stages of the gas bubble. Experimental excursion data are compared with REXCO computations, with emphasis upon the deformations produced by the pressure loads. The results of these comparisons verify the capability of the REXCO Code System to predict the response of containment structures and of the primary system components to the excursion pressure waves. Computations of the deformation of the containment vessel wall caused by pressure loads generated by high-explosive charges are compared with the experiments. The computation of deformations in the upper vessel region resulting from coolant slug impact is verified by comparison with the SL-1 accident data. 11 references. (auth)

55140 (CONF-720901-(Bks.1 and 2), pp 295-315) MEASUREMENT AND EVALUATION OF CROSS SECTIONS. Orphan, V. J. (Gulf Radiation Tech., San Diego, Calif.). 1972.

From Meeting on new developments in reactor physics and shielding calculations; Kiamesha Lake, NY. (12 Sep 1972).

The following types of neutron interaction cross sections which are important in reactor shielding are discussed: total, scattering (particularly angular distributions), capture and the photon energy spectra from nonelastic reactions. Examples are discussed for each of these cross-section types which typify the progress made in the development of new cross-section measurement techniques. Also, a few examples are given of advances made in the theoretical methods used in evaluations to predict the cross sections in the absence of experimental data. 40 references. (auth)

55141 (CONF-720901-(Bks.1 and 2), pp 316-24) DEVELOPMENT OF ENDF/B SHIELDING DATA PROCESSING CODES, AND INTEGRAL TESTS. LaBauve, R. J.; Seamon, R. E.; Weisbin, C. R.; Harris, D. R.; Muir, D. W. (Los Alamos Scientific Lab., N. Mex.). 1972.

From Meeting on new developments in reactor physics and shielding calculations; Kiamesha Lake, NY. (12 Sep 1972).

The national Evaluated Nuclear Data File (ENDF/B) now contains twelve materials important for shielding applications; these evaluations include data for neutron-induced photon production. During fiscal year 1973, photon production data for at least ten more important materials will become available, and six new photon production evaluations will be undertaken. Existing processing codes are being extended and improved, and new codes are being written to fully exploit the extensive data included in the ENDF/B. A comprehensive data testing program under the direction of the Cross Section Evaluation Working Group (CSEWG) is under way to uncover data deficiencies and suggest areas for improvement. Thus the ENDF/B is rapidly becoming the principal and most up-to-date source of data for shielding calculations. 29 references. (auth)

55142 (CONF-720901-(Bks.1 and 2), pp 418-30) ORNL SODIUM BENCHMARK EXPERIMENT. Maerker, R. E.; Muckenthaler, F. J.; Clifford, C. E. (Oak Ridge National Lab., Tenn.). 1972.

From Meeting on new developments in reactor physics and shielding calculations; Kiamesha Lake, NY. (12 Sep 1972).

The description of an experiment performed at the Tower Shielding Facility is presented which serves as a benchmark for deep neutron penetration through up to 15 ft of sodium. Results of calculations of the experiment are also described, using the MORSE multigroup Monte Carlo code and a preliminary version of the ENDF/B-III cross-section set for sodium. Comparison of the calculations with experiment indicate that the total neutron leakage above thermal energies penetrating 15 ft of sodium can be calculated to within 30% and neutrons penetrating up to 10 ft of sodium to within 10%. 12 references. (auth)

55143 (CONF-720901-(Bks.1 and 2), pp 459-70) DIFFUSION THEORY ANALYSES FOR FAST REACTOR SHIELD DESIGN. Boulette, E. T.; Marr, D. R. (Hanford Engineering Development Lab., Richland, Wash.). 1972.

From Meeting on new developments in reactor physics and shielding calculations; Kiamesha Lake, NY. (12 Sep 1972).

Comparisons of diffusion theory analyses with transport theory results indicate that diffusion theory adequately calculates integral quantities upon which fast reactor shield design criteria are based. Multi-dimensional analyses of fast reactor shield experiments support this conclusion and also demonstrate that the neutron cross section library may be adequately represented in fewer than 50 energy groups. 20 references. (auth)

55144 (CONF-720901-(Bks.1 and 2), pp 480-98) FAST REACTOR SHIELDING METHODS DEVELOPMENT. Mynatt, F. R.; Gritzner, M. L. (Oak Ridge National Lab., Tenn.). 1972.

From Meeting on new developments in reactor physics and shielding calculations; Kiamesha Lake, NY. (12 Sep 1972).

The elements of a shielding program based on a fundamental approach are discussed with a brief evaluation of the status of

the technology. A procedure is presented for utilizing the best features of Monte Carlo, discrete ordinates, and diffusion theory in coupled calculations providing good accuracy at minimum expense. As an example, results are presented from a four-step coupled two-dimensional discrete ordinates calculation for determination of the neutron and secondary gamma-ray dose rates in the FTR head compartment. An assessment of computational methods development plans is presented. 39 references. (auth)

55145 (GEAP-13822-1) LMFBR SHIELDING DESIGN EXPERIMENTS AND METHODS EVALUATION. First Quarterly Progress Report, January–March 1972. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Dept.). Apr 1972. Contract AT(04-3)-189. 26p. Dep. NTIS.

Both experimental and analytical work on axial and radial shields are being conducted, with the experimental part being performed at the ORNL Tower Shielding Facility. Activities and technical progress for the period January through March 1972 are reported. The major topics include program definition and scheduling, test assembly design and fabrication, analytical studies, and quality assurance. (auth)

55146 COLLECTION OF RADIOACTIVE IODINE BY FILTERING SYSTEM. Murata, T. (Hitachi Ltd., Tokyo). Kuki Seijo; 8: No. 7, 49-53(Mar 1971). (In Japanese).

Filtering system consisting of a charcoal filter to collect gaseous radioactive iodine and air filters to collect radioactive iodine particles is provided in emergency off-gas system of reactors. The air filters usually include a prefilter and a high efficiency air filter, and sometimes include further silver-plated copper mesh to reduce temperature rise of the charcoal filter due to decay heat of the radioactive iodine and demister. The iodine collection performance of the filtering system as a whole is described on the basis of test results in foreign countries and those obtained by experimentation. It became evident that iodine introduced into the filtering system is mostly collected by the air filters installed in front of the charcoal filter. This indicates that most of the iodine in the passing gas exists in the form of particles. There is a fairly large deviation in individual filter efficiency, reasons for which are: existence of organic iodine, possible change of its concentration, and incompleteness of the sampling system to measure efficiency. The high efficiency filter has good collection efficiency of the iodine at low temperature, for instance 60% at 25°C compared with about 5% at and above 70°C. This is mainly because of formation of waterdrops at the lower temperature, which helps the iodine collection with the high efficiency air filter. This is ascertained also by the fact that when the relative humidity is not less than 80%, the filter efficiency reaches 60%. Thus, the integrated filtering system efficiency for collecting the radioactive iodine is over 99%, and the filtering system seems to be sufficiently effective. (Japan)

Coolant System

Refer also to abstract 53305.

55147 (AI-AEC-Memo-12736) HNPF RETIREMENT: DISPOSITION OF SODIUM. Boardman, T. J.; Paulett, T. A. (Atomics International, Canoga Park, Calif.). 30 Sep 1968. Contract AT(04-3)-701. 137p. Dep. NTIS.

A detailed description is given of the planning, procedures, and actual removal of the sodium from the dismantled Hallam Power Reactor. The dismantling, draining, decontamination, and disposition of piping, pumps, tanks, and other components are discussed. Procedures for heating, cleaning, and pumping of the sodium are included. 10 references. (J.M.J.)

55148 (CISE-R-270) STEADY STATE AND TRANSIENT MEASUREMENTS ON A SCALED-DOWN MODEL OF A POWER CHANNEL OF THE CIRENE REACTOR PROTOTYPE. Peterlongo, G.; Possa, G. (Centro Informazioni Studi Esperienze, Milan (Italy)); Valli, G. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). Jun 1968. 41p. (In Italian). INIS.

A scaled down model (1 : 14) of a single power channel of the CIRENE prototype reactor, including a partial simulation of the steam drum, steam pipes and turbine, has been built and tested. A number of steady states of the system have been investigated, with the main purpose of defining stable paths for the start-up procedure. Measurements have been performed also for the study of coolant pressure dynamics with the following transient inputs: step variation of the heat input to the power channel, step variation of the stem position of the turbine valve, sinusoidal variation of the input of heat to the power channel. (INIS)

55149 (CONF-710548) SPECIALISTS' MEETING ON SODIUM–WATER REACTIONS SPONSORED BY THE INTERNATIONAL ATOMIC ENERGY AGENCY, INTERNATIONAL WORKING GROUP ON FAST REACTORS, 18–21 MAY 1971, MELEKESS, USSR. Summary Report and Papers. (International Atomic Energy Agency, Vienna (Austria)). Jul 1972. 263p, Dep. NTIS.

Twelve papers were presented and are abstracted separately. (J.M.J.)

For abstracts of individual papers see: 55150–55161.

55150 (CONF-710548–, pp 1-16) PRESENTATION MADE TO MEETING OF SODIUM-WATER REACTION SPECIALISTS. Lions, N.; Lacroix, A.; Schwab, B.; Lafon, A.; Trimouille, C. (Atomic Energy Commission, Cadarache, France). Jul 1972.

From Specialists' meeting on sodium–water reactions; Melekess, USSR (18 May 1971).

Tests on the Phenix Reactor steam generator confirmed the possibility of limiting the consequences of large-scale sodium–water reactions to insignificant damage to the steam generator. Rupture of one tube does not necessarily rupture adjacent tubes. Calculational methods were verified experimentally, so that simulation studies can be made with confidence. The safety of the Phenix steam generator was established. (J.M.J.)

55151 (CONF-710548–, pp 17-38) LARGE LEAK TESTS IN A MODEL OF A STRAIGHT-TUBE STEAM GENERATOR. Dumm, K. (INTERATOM, Bensberg, Ger.). Jul 1972.

From Specialists' meeting on sodium–water reactions; Melekess, USSR (18 May 1971).

The text of the paper is not given. Captions for slides are presented, followed by the slides, which contain schematics of the equipment tested, comparative data between the test model and the SNR design equipment, test parameters, and curves of measured results. (J.M.J.)

55152 (CONF-710548–, pp 39-56) EXPERIMENTAL STUDY OF THE INTERACTION OF WATER WITH SODIUM DURING SMALL LEAKS OF WATER INTO SODIUM. Andreev, P. A.; Borishanskii, V. M.; Zhokhov, K. A.; Belen'kii, M. Ya. Jul 1972.

From Specialists' meeting on sodium–water reactions; Melekess, USSR (18 May 1971).

The results of an experimental study of processes arising from a small leakage of water into sodium are presented. At low flow rates of liquid metal coolant (up to 1.5 m/sec) increased temperatures and pressures were observed in the region of the leak; the actual values depended on the magnitude of the leak. At small leak rates (10–100 g/hr) no increase in temperature or pressure was detected. Besides an increase in the temperature and pressure of the sodium coolant, the interaction of sodium with water gave rise to an environment which was corrosive towards the steam-generator pipework. The present work studies the possibility of corrosion damage to pipes in the case of an extremely small leakage of water into sodium (15–100 g/hr). The effects on the corrosion rate, of the magnitude of the leak, the location of the pipework relative to microcracks and the nature of the pipe material, were noted. 5 references. (auth)

55153 (CONF-710548–, pp 57-104) STUDY OF Na AND H_2O INTERACTION IN A ONE-MEGAWATT MODULAR STEAM GENERATOR. Kul'pin, B. V.; Mazanov, A. S.; Masnyi, V. F.; Gavrilin, A. I. (Scientific Research Inst. of Atomic Reactors, Melekess, USSR). Jul 1972.

From Specialists' meeting on sodium–water reactions; Melekess, USSR (18 May 1971).

An experimental study of a modular sodium–water steam generator of Czechoslovak design is described. A description of the test stand, data on the thermal balance of the steam generator in different regimes, and the design of a device to produce microleaks of water into sodium to simulate dissolution of the tube bundle of the steam generator and an emergency system for determining the time of the appearance of the leak and preventing breakdown of the steam generator are presented. Results of metallographic analysis of the tube bundle material in the breakdown zone and at a distance from it are presented. 7 references. (auth)

55154 (CONF-710548–, pp 105-28) METHODS OF INDICATION, OPERATION OF A STEAM GENERATOR AND SECONDARY CIRCUIT IN THE CASE OF SLIGHT LEAKAGE OF WATER INTO SODIUM. Kozlov, F. A. Jul 1972.

From Specialists' meeting on sodium–water reactions; Melekess, USSR (18 May 1971).

A study of the problems associated with the ingress of water to sodium through boiler leakage is presented. Expressions are adduced for the solubilities of hydrogen, oxygen, products of the interaction of water and sodium, and sodium hydroxide in sodium; the rate constants have been determined for the reactions of sodium with hydrogen and with sodium hydroxide over the tempera-

ture range 300–450°C; the results of corrosion tests of a Cr–Mo steel in the vicinity of the leak are presented; the development of a system for monitoring the leakage of water into sodium is described together with preliminary experimental results of an acoustic method for detecting a leak; problems of purifying sodium from its reaction products with water are discussed. 5 references. (auth)

55155 (CONF-710548–, pp 129-54) OUTLINE OF PNC'S ACTIVITIES IN THE FIELD OF SODIUM-WATER REACTION. Hori, Masao; Sato, Minoru; Nei, Hiromichi; Tanaka, Toshikazu; Hishida, Makoto Jul 1972.

From Specialists' meeting on sodium–water reactions; Melekess, USSR (18 May 1971).

The Japanese sodium–water reaction project (SWAT), carried out to develop safe, reliable steam generators for the Monju fast breeder reactor, is described. The test equipment and the computer codes used are listed. Tests carried out are described. Schematic diagrams of equipment and test parameters are presented. 12 references. (J.M.J.)

55156 (CONF-710548–, pp 155-70) DETECTION OF SMALL-LEAK SODIUM-WATER REACTION IN THE PROTOTYPE LMFBR STEAM GENERATOR BY IN-SODIUM TYPE HYDROGEN DETECTOR. Ikemoto, Ichiro; Hori, Masao. Jul 1972.

From Specialists' meeting on sodium–water reactions; Melekess, USSR (18 May 1971).

The large-leak sodium–water reaction accident in steam generator may occur following the "wastage" of tubes because of a small leak. The possibility of the accident propagation and the required sensitivity of an in-sodium hydrogen detector are examined in the case of the prototype LMFBR steam generator. The hydrogen detector is found out to be highly effective for the detection of very small leaks (5×10^{-3} lb/sec), and the required sensitivity here is less than 0.1 ppm hydrogen concentration. In the very severe case, however, development of detectors which have no delay time, such as an acoustic detector, will be required. (auth)

55157 (CONF-710548–, pp 171-86) ANALYSES OF THE SODIUM-WATER REACTION PRESSURE AND ITS PROPAGATION IN THE SODIUM SYSTEM. Sakano, Kosuke; Tanaka, Yoshihisa; Mochizuki, Hirozi (Kawasaki Heavy Industries, Ltd., Tokyo). Jul 1972.

From Specialists' meeting on sodium–water reactions; Melekess, USSR (18 May 1971).

One dimensional sodium–water reaction code SOWACS that assumes sodium and water to be compressible in order to calculate the propagation of pressure wave was developed and tested. The initial peak pressure calculated at the reaction point was different from the experimental one. In order to improve the accuracy of the calculation of the peak pressure at the reaction point, it will be better to change the model of sodium flow at the beginning of the reaction to the spherical model. Comparing with the pressure (126 ata) at the faulted evaporator, the pressure at the adjacent components and piping becomes lower during it propagates in the secondary sodium system, for example 47 ata at the adjacent evaporators, 25 ata at the super heaters and reheaters and 18 ata at the piping. (auth)

55158 (CONF-710548–, pp 187-205) SOME NOTES ON SODIUM/WATER REACTION WORK. Bray, J. A. (Dounreay Experimental Reactor Establishment, Thurso, Scotland). Jul 1972.

From Specialists' meeting on sodium–water reactions; Melekess, USSR (18 May 1971).

The Super–NOAH rig, for studying large scale sodium–water reactions, is described. Parameters of the experiments are given. Reaction products, which settled to the bottom of the reaction vessel, are described. The design for the Prototype Fast Reactor heat exchanger is presented schematically. (J.M.J.)

55159 (CONF-710548–, pp 206-12) REQUIREMENTS FOR STEAM GENERATOR DESIGN AND SYSTEMS TO ENSURE SAFETY IN THE CASE OF FAILURES IN THE TUBES OF HEAT EXCHANGE SURFACES. Titov, V. F.; Bogdanovich, P. N.; Poplavskii, V. M.; Bagdasarov, Yu. E. Jul 1972.

From Specialists' meeting on sodium–water reactions; Melekess, USSR (18 May 1971).

Experience indicates that the proposed designs ensure the necessary degree of control and safety for sodium steam generators on failure of the heat exchange tubes. However, the safety systems adopted for the designs in question do not eliminate the need for further investigation and development work to improve the reliability in service of sodium steam generators. (auth)

55160 (CONF-710548–, pp 213-20) STATUS OF THE SODIUM-WATER REACTION STUDIES IN ITALY. Jul 1972.

From Specialists' meeting on sodium–water reactions; Melekess, USSR (18 May 1971).

The sodium–water reaction study program in Italy is described very briefly. Historical information is mentioned, and future plans are considered. (J.M.J.)

55161 (CONF-710548–, pp 221-42) ANALYTICAL AND EXPERIMENTAL STUDY OF A REACTING WATER-SODIUM FLOW. Kul'pin, B. V.; Mazanov, A. S. (Scientific Research Inst. of Atomic Reactors, Melekess, USSR). Jul 1972.

From Specialists' meeting on sodium–water reactions; Melekess, USSR (18 May 1971).

The rates of breakdown of 1Kh18N9T austenitic steel in the zone of interaction between sodium and water at small leaks were studied. The results of a determination of the weight loss of a target of this field in the interaction zone are presented and curves showing the burn-through time of the targets as a function of the sodium temperature from 350 through 600°C and the distance from the point of the leak are given. Also given are the results of a study of the temperature field of targets located in the reaction zone and the results of a determination of the burn-through time as a function of the thickness of the target. 5 references. (auth)

55162 (CONF-710959–, Paper 2) OBSERVATIONS ON THE BEHAVIOR OF RADIOACTIVE PRODUCTS ON RAPSODIE. De Fremont, R. (CEN, Cadarache, France). 12p.

From Meeting on fission and corrosion product behaviour in primary systems of LMFBR's; Bensberg, Germany (20 Sep 1971).

During an extensive shutdown for modification, after 3 years of operation, all accessible parts of the primary cooling system of the Rapsodie Reactor were inspected. One failed fuel pin was found, permitting direct contact between the fuel material and the liquid sodium coolant. Measurements of ^{137}Cs levels are given. Radioactivity levels were measured throughout the primary coolant loop. (J.M.J.)

55163 (CONF-710959–, Paper 3) DECONTAMINATION EXPERIENCE ON RAPSODIE. De Fremont, R. (CEN, Cadarache, France). 2p.

From Meeting on fission and corrosion product behaviour in primary systems of LMFBR's; Bensberg, Germany (20 Sep 1971).

Decontamination of the Rapsodie primary coolant loop and pumps is described. Decontamination factors for the primary radionuclides are given. (J.M.J.)

55164 (CONF-710959–, Paper 8) RADIOACTIVE MATERIAL TRANSPORT IN FLOWING SODIUM SYSTEMS. Brehm, W. F.; Koehmstedt, P. L.; Kovacevich, E. A.; Shannon, D. W. (Battelle-Northwest Labs., Richland, Wash.). 17p.

From Meeting on fission and corrosion product behaviour in primary systems of LMFBR's; Bensberg, Germany (20 Sep 1971).

The transport of activated corrosion products in liquid sodium was studied. It was found that fluid boundary-layer resistance to deposition of species exists for many isotopes; deposited activity can either release from the deposition site and migrate through the loop, or diffuse into the base metal; and deposited crud activity can create reactor maintenance problems. The release, transport, and deposition is not yet fully understood. 12 references. (J.M.J.)

55165 (CONF-710959–, Paper 9) CORROSION AND DEPOSITION OF IRRADIATED STAINLESS STEEL IN SODIUM. Brehm, W. F.; Kovacevich, E. A.; Shannon, D. W. (Battelle-Northwest Labs., Richland, Wash.). 21p.

From Meeting on fission and corrosion product behaviour in primary systems of LMFBR's; Bensberg, Germany (20 Sep 1971).

Studies were made of the corrosion in flowing liquid sodium of 300 series stainless steels. At 1200°F, 25 ft per sec sodium velocity, and 10 ppM oxygen in the sodium, the rate of metal loss was 0.0013 cm per year, an acceptable rate. The problem of radioisotopes included in the corrosion products is considered. The radioisotopes involved are identified. 8 references. (J.M.J.)

55166 (CONF-710959–, Paper 10) FISSION AND CORROSION PRODUCT BEHAVIOUR IN PRIMARY SYSTEMS OF LMFBR's: A BRIEF REVIEW OF CURRENT STATUS OF WORK BEING CARRIED OUT IN UK. Thorley, A. 11p.

From Meeting on fission and corrosion product behaviour in primary systems of LMFBR's; Bensberg, Germany (20 Sep 1971).

Techniques were developed to study the behavior of radioactive materials in sodium systems. Studies are being made in the Dounreay Fast Reactor and in out-of-pile loops. The release,

transport, and deposition of corrosion products in flowing sodium are studied using tracer techniques. Mass transport of materials in sodium at various temperatures, velocities, and impurity levels was studied. The effect of imposed stresses on cladding materials in a corrosive, carburizing environment was examined. The effects of corrosion and deposition on the performance of a sodium loop was considered. 10 references. (J.M.J.)

55167 (CONF-710959–, Paper 11) BEHAVIOUR OF RADIOACTIVE IMPURITIES IN DFR PRIMARY LIQUID METAL COOLANT. Davies, R. A.; Drummond, J. L. (Dounreay Experimental Reactor Establishment, Scotland). 22p.

From Meeting on fission and corrosion product behaviour in primary systems of LMFBR's; Bensberg, Germany (20 Sep 1971).

The main oxide-forming fission products are present as a suspension of fine insoluble particles in the NaK which tend to deposit on metal surfaces. This suspension also contains fissile material formed by corrosion of uranium metal and disintegration of experimental oxide fuel from failed pins. It is difficult to obtain representative samples of NaK for fission product and fissile material analysis. There is no evidence in DFR that cesium is deposited on either the pipework or in the cold trap. The major part of the activity on components discharged from DFR can be removed by a water wash. 4 references. (auth)

55168 (CONF-710959–, Paper 12) CORROSION MASS TRANSFER IN PRIMARY SYSTEMS OF LMFBR'S. Menken, H. G. (INTERATOM, Bensberg, Ger.). 27p.

From Meeting on fission and corrosion product behaviour in primary systems of LMFBR's; Bensberg, Germany (20 Sep 1971).

Estimates of corrosion problems in the SNR were made based on corrosion loop studies. The SNR mockup corrosion loop is described. A corrosion and deposition model was formulated. Results calculated from the model were compared with those obtained experimentally. (J.M.J.)

55169 (CONF-710959–, Paper 13) SURVEY ABOUT CALCULATION METHODS FOR THE ACTIVITY INVENTORY IN THE PRIMARY SYSTEM OF SNR. Merkel, A. (INTERATOM, Bensberg, Ger.). 8p.

From Meeting on fission and corrosion product behaviour in primary systems of LMFBR's; Bensberg, Germany (20 Sep 1971).

The sources of activity release to the coolant are summarized. Boundary conditions for the fission product release during normal operation are given and used for the design of the SNR power plant. For abnormal reactor operation of the SNR, that is for accident conditions, among the various improbable malfunctions, the activity release is only discussed for the hypothetical design basis accident which is taken for the laying out of the primary system. (auth)

55170 (CONF-710959–, Paper 14) ANALYTICAL DETERMINATION OF IMPURITIES IN SODIUM OF LMFBR. Schillings, K. L. (INTERATOM, Bensberg, Ger.). 13p.

From Meeting on fission and corrosion product behaviour in primary systems of LMFBR's; Bensberg, Germany (20 Sep 1971).

The status of analysis of trace impurities in sodium at INTERATOM is given. The analytical methods for the most important elements were reviewed. The results obtained by the vacuum distillation and its following procedures indicate the excellent precision of less than ±1 ppM under the conditions that the impurities are within 10 ppM. This accuracy is valid for the elements C, O, Cl, H, and some metals. New studies for determining the radioactive trace impurities were discussed. (auth)

55171 (CONF-710959–, Paper 15) IMPURITIES IN COVER GAS SYSTEMS: SOME ASPECTS OF THEIR EFFECTS ON THE DESIGN OF LMFBR's. Webster, J. M. 7p.

From Meeting on fission and corrosion product behaviour in primary systems of LMFBR's; Bensberg, Germany (20 Sep 1971).

Sodium present as vapor and aerosols need to be considered as an impurity of fast reactor cover gas systems. Effective processes are required for its removal in order that recycled cover gas can be used as a purge for mechanisms and penetrations susceptible to sodium deposition or as a preliminary stage in a cover gas fission product removal plant, should this be required. Although the liquid metal coolant will act as a getter for the reactive constituents of air and moisture which could be introduced into the system during in flask and maintenance operations, problems due to deposition could arise. The build up of nitrogen could result in metallurgical features and measures may be required for removal from the cover gas. Cover gas activity caused by reactor operation with defective fuel in the core is expected to arise mainly from the fission gases. (auth)

55172 (CONF-710959–, Paper 16) BRIEF OUTLINE OF RADIATION AND REPAIR ENGINEERING PROGRAM PLAN. Brehm, W. F. (Hanford Engineering Development Lab., Richland, Wash.). 8p.

From Meeting on fission and corrosion product behaviour in primary systems of LMFBR's; Bensberg, Germany (20 Sep 1971).

The possibility of unfavorably high radiation levels in the FFTF heat transport system maintenance cells, arising from deposited corrosion product radionuclides, has been identified. The Radiation and Repair Engineering Program has been set up to find methods of reducing or coping with the radioactivity burden. The specific factors that contribute to the radiation levels, and the feasibility of reducing or accommodating each one are described graphically. A brief outline of overall program objectives is given. (auth)

55173 (CONF-710959–, Paper 17) CORROSION AND DEPOSITION BEHAVIOUR OF STEEL MATERIAL IN SODIUM SYSTEMS. Thorley, A. 11p.

From Meeting on fission and corrosion product behaviour in primary systems of LMFBR's; Bensberg, Germany (20 Sep 1971).

The corrosion and deposition of ferrous materials in simple liquid sodium loops were studied. Mass transport of materials in sodium at various temperatures, flow velocities, and impurity levels were considered. The effect of imposed stresses on cladding materials under corrosive and carburizing conditions was measured. The pattern of corrosion and deposition of corrosion products at various points in a non-isothermal sodium loop was studied. (J.M.J.)

55174 (EURFNR-986) PRESSURE DROP FOR ISOTHERMAL, INCOMPRESSIBLE TURBULENT FLOW IN ROD BUNDLES WITH HEXAGONALLY ARRANGED RODS. Rehme, K. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). Translation of report KFK-1427. 45p. Dep. NTIS.

Work Performed under United States–Euratom Fast Reactor Exchange Program.

Systematic investigations were carried out on the pressure drop for an incompressible, isothermal, fully developed turbulent flow in rod bundles with hexagonal arrangement of rods. The results of measurements of the pressure drop over a range of Reynolds numbers $Re = 6 \times 10^2 \div 2 \times 10^5$ in test sections are reported. The rods with rod distance ratios of $P/D = 1.025 \div 2.324$ were surrounded by hexagonal channels. The number of rods was 7, 19, 37, and 61 respectively. On the basis of a critical survey of data from the literature and of the new measured results it was possible to give a generally valid statement about the pressure drop in rod bundles which is in contrast to numerous experimental and theoretical results by other authors. The pressure drop coefficient quickly rises from approximately 60% of the circular tube value for closely packed rods ($P/D = 1.0$) to the value for circular tubes for $P/D \approx 1.08$. For even higher rod distance ratios, the pressure drop coefficients rise but a little to about 10% above the values for circular tubes at $P/D = 2.0$. The number of rods in the rod bundle has no measurable effect on the pressure drop coefficient. 59 references. (auth)

55175 (GEAP-10207-26) REACTOR PRIMARY COOLANT SYSTEM RUPTURE STUDY. Progress Report No. 26, October 1971–March 1972. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Apr 1972. Contract AT(04-3)-189. 77p. Dep. NTIS.

Testing was completed on a series of three 550°F, stainless-steel, butt-weld specimens and on the first cyclic pressure plus cyclic bending, stainless steel elbow specimen. Fatigue specimen notch root strains have been calculated with an elastic-plastic finite element computer program. Peak strains during cyclic loading have been measured with miniature strain gages. The Dresden 1 test loop has accumulated over 3900 hours of operation at test conditions (510°F, 1040 psig). A total of 81 of the 149 fatigue specimens being cyclically loaded in the loop have failed: 36 of 71 Type-304 stainless steel specimens, 15 of 28 Type-304L stainless steel specimens, 3 of 23 Inconel-600 specimens, and all of the 27 carbon steel specimens. (auth)

55176 (KFK-1548) PHENOMENOLOGICAL INVESTIGATION OF THE FLOW DISTRIBUTION BEHIND LOCAL COOLANT CHEMICAL BLOCKAGE IN ROD BUNDLES. Basmer, P.; Kirsch, D.; Schultheiss, G. F. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Reaktorentwicklung). Jan 1972. 32p. (In German). Dep. NTIS (U. S. Sales Only).

A hexagonal SNR-subassembly has been bisected between two corners. Closing this part by a plexiglas plate, it was possible to observe the flow behavior. Experiments have been performed with water and air bubbles as flow indicators. In all experiments, a coherent region of 41% of the flow area was completely or partially blocked. For different positions of the blockage, the influence of the spacer grid, the pin bundle, and the wall structure of the plexiglas upon the wake downstream of the blockage have been investigated for two Reynolds numbers. A reduced fluid flow rate within the blocked region has been arranged by drilling narrow holes through the blockage. It is concluded that the dimensions of the wake are practically independent from the Reynolds number within the investigated range. Even in a pin bundle, a distinct recirculation flow develops in the wake. A flow within the blocked region of about 15% of the whole flow rate destroys the recirculation zone in the wake behind the blockage. (auth)

55177 (ORNL-TM-3344) EXPERIENCE WITH SODIUM FLUOROBORATE CIRCULATION IN AN MSRE-SCALE FACILITY. Smith, A. N. (Oak Ridge National Lab., Tenn.). Sep 1972. Contract W-7405-eng-26. 132p. Dep. NTIS.

A eutectic mixture of sodium fluoroborate and sodium fluoride was circulated isothermally at a rate of about 800 gpm for 11,567 hr in a 4-in.-IPS Inconel test loop as part of the program to evaluate the fluoroborate salt for use as a secondary coolant for the Molten-Salt Breeder Reactor. Except for brief periods at 900, 1150, and 1275°F, the bulk salt temperature was controlled at 1025°F. The objective of the experiment was to obtain general experience in the handling and circulation of the fluoroborate salts, with emphasis on the pumping characteristics and on the design and operation of the gas system as it related to handling BF_3 and controlling the salt composition. The test results indicated that water test data may be used to predict the performance of molten-salt pumps with the fluoroborate salt, that reliable performance may be obtained from systems handling BF_3 gas if precautions are taken to exclude water and water-related impurities, that control of the salt composition should not be a problem, and that the thermal conductivity of the gas phase above the salt surface may be used as an indicator for monitoring the salt composition. Preliminary tests were made to examine the feasibility of protecting reactor heat transfer surfaces by preferential deposition of corrosion products in a cold trap. Further work is recommended in this area. The test work indicated that flow restrictions in the off-gas line can be eliminated by pretreatment of the salt to remove volatile impurities and by the use of a hot-mist trap and a cold filter in the off-gas line at the pump bowl outlet. 13 references. (auth)

55178 (RD/B/N-2364) IGNITION OF LIQUID METAL: PEROXIDE MIXTURES. Newman, R. N.; Smith, C. A. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Jun 1972. 6p. Dep. NTIS (U. S. Sales Only).

Mixtures of sodium metal and sodium peroxide were ignited both in air and under inert atmospheres. The burning rate and spectra from the flash were recorded. The relevance of this type of reaction in relation to hazards involved in the use of liquid sodium and NaK in civil fast reactors is discussed. (auth)

55179 (TID-25887) BOILING CRISIS AND CRITICAL HEAT FLUX. Tong, L. S. (Westinghouse Electric Corp., Pittsburgh, Pa.). 1972. Contract AT(11-1)-2189. 89p. Dep. NTIS.

The ratio of the predicted critical heat flux (CHF) to the reactor heat flux is used as an index of the power capability of water reactors. Numerous boiling heat-transfer and two-phase-flow studies over the past 15 years have put emphasis on exploring the boiling-crisis mechanisms and on perfecting the CHF predictions. Unfortunately, the problem is more complicated than was thought. Thus far no overall analytical solution has been obtained, and the design equations for CHF predictions are empirical. In this review various types of boiling crisis are categorized according to four major flow patterns: pool boiling, bubbly flow, and normal flow across a cylinder. The physical mechanisms of these boiling crises are described. Experimental observations are summarized and used for verifying various analyses. The missing links in the analyses are identified, and future work is recommended. 123 references. (auth)

55180 EXPERIMENTS ON THE FLOW PAST SPHERES AT VERY HIGH REYNOLDS NUMBERS. Achenbach, E. (Kernforschungsanlage, Juelich, Ger.). J. Fluid Mech.; 54: No. 3, 565-75(8 Aug 1972).

In the Nuclear Research Laboratories at Juelich a gas-cooled high temperature reactor working with spherical fuel elements is being developed. The spheres, which have a diameter of 0.06 m, are transported pneumatically through tubes (diameter $d_t = 0.065$ m) under the conditions of the primary cooling gas, i.e., helium at 40 bars and 250°C. Because of the high pressure of the system large Reynolds numbers are to be expected. It was supposed that, during the transporting process, flow around the sphere could reach the critical state, which is characterized by a low drag coefficient and unsteady flow conditions. Work is reported concerning the flow past spheres in the Reynolds number range 5×10^4 Re 6×10^6. Results are reported for the case of a smooth surface. The total drag, the local static pressure and the local skin friction distribution were measured at a turbulence level of about 0.45%. The present results are compared with other available data as far as possible. Information is obtained from the local flow parameters on the positions of boundary-layer transition from laminar to turbulent flow and of boundary-layer separation. Finally the dependence of friction forces on Reynolds number is pointed out. (auth)

55181 WHAT RESEARCHERS LEARNED ABOUT VALVE PERFORMANCE IN REACTOR HEAT TRANSPORT SYSTEMS. Can. Contr. Instrum.; 11: No. 4, 29-31(Apr 1972).

The economics of Canada's reactor operations place stringent demands on valve performance. Low leakage, dependability and maintainability are of key importance. Most commercial types have weaknesses in one area or the other and a test program at AECL identified problem areas. The work has uncovered new technology which is now being applied to existing reactor valve problems. (auth)

55182 STUDY AND TESTS OF SMALL COMPONENTS OF SECONDARY CIRCUITS OF FAST Na COOLED REACTORS. Beaufrere, J.; de Montardy, A.; Nedelec, J. (Electricite de France, Ecuelles). Energ. Nucl. (Paris); 14: No. 1, 17-28 (1972). (In French).

In fast Na cooled reactors, it is necessary to interpose an intermediate Na circuit between the Na circuit cooling the core and the water vapor circuit feeding the turbine. The construction of the auxiliary equipment of the circuit is indicated: valves and taps, safety membranes, and sealed joints. (France)

Fuels and Fuel Elements

Refer also to abstract 53553.

55183 (ANCR-1038) EVALUATION OF FILAMENT-TYPE ELECTRIC HEATER ROD AS EMPLOYED IN SINGLE-LOOP SEMISCALE TO SIMULATE UO_2 FUEL RODS. Ewers, D.; Larson, J. R. (Aerojet Nuclear Co., Idaho Falls, Idaho). May 1972. Contract AT(10-1)-1375. 40p. Dep. NTIS.

This analysis compares the thermal response, during the blowdown phase of a loss-of-coolant accident, of the electrically heated filament-type heater rods used in the single-loop semiscale system with the thermal response of uranium dioxide fuel rods typically used in a light-water reactor. The analysis was conducted to determine how well the heater rod would simulate a UO_2 fuel rod, to optimize the method of power control to the heaters in the single-loop semiscale test series, and to guide future design of heater rods to be used in later test series. The analysis was accomplished using the HEAT-1 computer code. The results of this analysis indicate that comparable surface temperatures and surface heat fluxes for the two types of rods are very difficult to obtain, primarily because of the greater amount of heat stored in the uranium dioxide fuel rod. Maintaining the initial steady state power generation rate during the transient appears to be the best method for simulating the UO_2 fuel rod thermal response in the early, transient portion of an LOCA. 5 references. (auth)

55184 (ANL/EBR-57) XENON-TAGGING OF EBR-II DRIVER FUEL. EBR-II Project. Madson, A. A.; Laug, M. T. (Argonne National Lab., Ill. Argonne National Lab., Idaho Falls, Idaho). Feb 1972. Contract W-31-109-Eng-38. 24p. Dep. NTIS.

Twenty partially bonded EBR-II driver-fuel elements for an experiment were xenon-tagged with an evacuate-cryogenic transfer method. The xenon was frozen into the element plenum by immersing, in liquid argon, the sodium-loaded jacket complete with the fuel pin. More than 3 cm^3 (STP) of xenon were transferred in order to deliberately increase the plenum pressure so that release of tag upon cladding failure would be ensured. The equipment and procedures used are described, and the method is evaluated. 5 references. (auth)

55185 (CONF-710959-, Paper 1) TEMPETE TEST: IN PILE EXPERIMENT ON THE TRANSFER OF FISSION GASES. De Fremont R. (CEN, Cadarache, France). 5p.

From Meeting on fission and corrosion product behaviour in primary systéms of LMFBR's; Bensberg, Germany (20 Sep 1971).

The feasibility of using rare gas tracers to locate failed fuel

elements in Rapsodie and Phenix reactors was demonstrated. The transport of rare gases in a reactor core under real reactor operating conditions was studied. (J.M.J.)

55186 (EURFNR-985) TREATMENT OF THE MECHANICAL AND THERMAL BEHAVIOR OF FUEL RODS IN SATURN 1. Kaempf, H.; Elbel, H.; Depisch, F. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Material und Festkoerperforschung). Translation of report KFK-1477. 48p. Dep. NTIS.

Work Performed under United States-Euratom Fast Reactor Exchange Program.

In SATURN 1 the time history of a fuel pin concerning the radial distributions of temperature, stress, porosity and geometry changes is calculated. The operating fuel pin conditions such as linear rod power, outside temperature of the cladding and outside pressure are time dependent input data, so steady state and cyclic conditions are taken into account. The following material phenomena essential for the mechanical and thermal behavior are interconnected in SATURN 1: creep of fuel and clad, swelling of fuel and clad, thermal expansion, crack formation, fission gas release, porosity migration, and heat transfer fuel-clad. Three thermal-mechanical states are distinguished: a) fuel and clad in mechanical interaction, b) freestanding fuel and clad stressed by gas and coolant pressure, and c) freestanding stressed clad in contact or not in contact with cracked fuel assumed to be free of stresses. Three fuel zones are distinguished especially with view to different mechanical behavior. To demonstrate the manifold possibilities of SATURN 1 several illustrative applications are given. (6 references) (auth)

55187 (EURFNR-989) IN-PILE COMPATIBILITY OF OXIDE FUEL. Goetzmann, Odo (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Material und Festkoerperforschung). 26 Jan 1972. 14p. Dep. NTIS.

Work performed under United States-Euratom Fast Reactor Exchange Program.

Radiation effects in reactor fuel elements during burnup, affecting the compatibility of the fuel material with the stainless steel cladding, are considered. While these materials are initially compatible, the formation of fission products, plus the liberation of oxygen from the oxide fuel materials, can become critical factors in the compatibility. In particular, tellurium and cesium have proven to be critical. The effects of temperature are considered. (J.M.J.)

55188 (EURFNR-1020) FRICTION FACTORS OF A CLUSTER OF 19 ROUGH RODS. Savatteri, C. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). Apr 1972. 24p. (EUR-4728; KFK-1588). Dep. NTIS (U. S. Sales Only).

Work performed under United States-Euratom Fast Reactor Exchange Program.

On the basis of the laws applicable to velocity distribution on smooth and roughened surfaces, as obtained for simple geometries (circular tubes, annular gap), a method is indicated which allows the calculation of friction coefficients and flow distribution in artificially roughened rod bundles. Using this method of calculation, the results of measurements found for a rod bundle of 19 roughened rods in hexagonal arrangement and with a smooth channel wall yielded a parameter $R(h^+)$ which is in good agreement with values applicable to simpler geometries. (15 references) (auth)

55189 (GEAP-10028-39) SODIUM-COOLED REACTORS FAST CERAMIC REACTOR DEVELOPMENT PROGRAM. Thirty-Ninth Quarterly Report, May-July 1971. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Dept.). Aug 1971. Contract AT(04-3)-189. 99p. Dep. NTIS.

EXPERIMENTAL BREEDER REACTOR-2 — fuel irradiation testing in, status of mixed oxide
FAST CERAMIC REACTOR — fuel elements for, development during May to July 1971
— core for, design and kinetics analysis of
— safety of, transient overpower and coolant flow loss effects on
INCOLOY 800 — radiation effects on swelling and mechanical properties of, fast neutron, (E)
LIQUID METAL FAST BREEDER REACTOR — fuel elements for, development of stainless steel clad plutonium oxide (PuO_2)-uranium oxide (UO_2)
NEUTRONS, FAST — effects on Incoloy 800 and stainless steels Type 316, Type 321, and Type 347
PLUTONIUM OXIDES, PuO_2 — PuO_2-UO_2, radiation effects testing of fuels of
— PuO_2-UO_2, properties of fuels of, mechanical, physical, and thermal, (E)
REACTOR FUEL ELEMENTS — performance of defected mixed plutonium oxide (PuO_2)-uranium oxide (UO_2) fast, in flowing liquid sodium
— cladding for mixed plutonium oxide (PuO_2)-uranium oxide (UO_2) fast, development and testing of stainless steel
— radiation effects testing of mixed plutonium oxide (PuO_2)-uranium oxide (UO_2) fast
STAINLESS STEEL — radiation effects on swelling and mechanical properties of Type 316, Type 321, and Type 347, fast neutron, (E)
URANIUM OXIDES, UO_2 — PuO_2-UO_2, radiation effects testing of fuels of
— PuO_2-UO_2, properties of fuels of, mechanical, physical, and thermal, (E) (J.M.J.)

55190 (GEAP-10028-42) SODIUM-COOLED REACTORS FAST CERAMIC REACTOR DEVELOPMENT PROGRAM. Forty-Second Quarterly Report, February-April 1972. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Dept.). May 1972. Contract AT(04-3)-189. 123p. Dep. NTIS.

FAST CERAMIC REACTOR — fuel elements for, development during February to April 1972
— core for, design and kinetics analysis of
— safety of, transient overpower and coolant flow loss effects on
— safety of, development of models for analysis of
FAST FLUX TEST FACILITY — fuel element assemblies for, design of grid spaced driver
NEUTRONS, FAST — radiation effects on stainless steels Type 304, Type 316, Type 321, and Type 321-H
REACTOR FUEL ELEMENTS — performance of defected mixed plutonium oxide (PuO_2)-uranium oxide (UO_2) fast, in flowing liquid sodium
— fission products in, migration of cesium and tellurium
— radiation effects testing of mixed plutonium oxide (PuO_2)-uranium oxide (UO_2) fast
— cladding for mixed plutonium oxide (PuO_2)-uranium oxide (UO_2) fast, development and testing of stainless steel
STAINLESS STEEL — radiation effects on swelling and mechanical properties of Type 304, Type 316, Type 321 and Type 321-H (J.M.J.)

55191 (ORNL-TM-3656) FINAL SYSTEMS DESIGN DESCRIPTION OF THE FAILED FUEL MOCKUP (FFM) OF THE LIQUID-METAL FAST BREEDER REACTOR. Grindell, A. G.; MacPherson, R. E. (comps.) (Oak Ridge National Lab., Tenn.). Sep 1972. Contract W-7405-eng-26. 187p. Dep. NTIS.

The Failed Fuel Mockup (FFM) is an electrically heated, air-cooled sodium test facility in which a wide variety of out-of-pile testing can be performed with electric cartridge heaters that simulate the fuel pins in a portion of a liquid-metal fast breeder reactor (LMFBR) fuel assembly. In experiments carried out in the FFM, the behavior of the simulated partial subassembly under blockage and other test conditions of LMFBR interest can be studied, and information on thermal and hydraulic characteristics of various subassembly configurations may be obtained. The test section, which contains the electric heaters, is designed for 100 psi at 1300°F. The FFM can supply 442 kW of power to the test section, which consists initially of 19 electric cartridge heaters. The test section is conveniently removable from the facility to change the type or location of the flow blockage and also the configuration of the test section or instrumentation. The variable-speed sodium pump is capable of supplying up to 100 gpm of sodium to the test section and simultaneously as much as 200 gpm to the test section bypass line. An electronic data acquisition system is used to record pertinent test measurements on magnetic tape for computer processing. The facility is equipped with automatic equipment to permit unattended operation. The final design description of the several systems that make up the FFM is presented: the sodium circulation, cooling, and purifications systems; the test section; the electrical power system; the inert-gas system, and the unattended operation system. (auth)

55192 (ORNL-TM-3761) PRELIMINARY COOLANT TEMPERATURE OSCILLATION MEASUREMENTS AT THE FUEL-FAILURE MOCKUP. Fry, D. N.; Kerlin, T. W. (Oak Ridge National Lab., Tenn.). Aug 1972. Contract W-7405-eng-26. 23p. Dep. NTIS.

A feasibility study was conducted at the Fuel-Failure Mockup to determine if fluctuations in coolant temperature can be used to study flow and heat transfer mechanisms in a simulated Liquid-Metal Fast Breeder Reactor (LMFBR) fuel rod assembly. Thermocouple signals were cross correlated to obtain the gain and phase lag between thermocouple locations. The results of gain and phase measurements between wire-wrap thermocouples in bundle

1A show that the effect of wire wraps on the crossflow is experimentally observable. Also, these results, obtained at a frequency of 2 Hz, suggest that the crossflow might be proportional to the 0.8 power of the bulk flow. (auth)

Auxiliary Systems and Engineered Safeguards

55193 (BAW-10016) ANALYSIS OF ANTICIPATED TRANSIENTS WITHOUT TRIP. Scott, J. F.; Galan, V. J.; Cartin, L. R.; Heldenbrand, W. R.; Penland, J. R. (Babcock and Wilcox Co., Lynchburg, Va. (USA). Nuclear Power Generation Div.). Sep 1972. 98p.

A study was conducted to determine the consequences of anticipated transients without trip and to evaluate the probability of occurrence for these transients. The study was performed on a typical 177-fuel assembly plant at a rated power of 2772 MW(t). It is concluded that there is no significant potential for system damage due to anticipated transients without trip. (13 references) (auth)

55194 CONVEYING TUBE FOR THE PNEUMATIC TRANSFER OF SPHERICAL ELEMENTS. Mauersberger, R.; Faber, R.; Rausch, W.; (and others) (to Hochtemperatur-Reaktorbau GmbH). German Patent 2,060,673. (In German).

The tube is characterized in that it has at least three longitudinally running internal ribs which will prevent contact of the spherical fuel elements with the tube wall itself. The number, height, and arrangement of the ribs have been calculated so that even spheres with smaller diameters will not touch the wall of the tube. (GF)

Operation and Economics

Refer also to abstract 55376.

55195 (AECL-4254) CANADA'S NUCLEAR POWER PROGRAM IN CONTEXT WITH THAT OF THE WORLD. Mooradian, A. J. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Jun 1972. 10p. Dep. NTIS (U. S. Sales Only). AECL $0.50.

Canadian nuclear capacity is based on the CANDU concept, which is a unique product of the Canadian Nuclear Power Program. With the success of the Pickering Generating Station and promising results from boiling light-water and organically cooled reactors, the future of the Canadian concept as a highly competitive reactor system is assured. (auth)

55196 (CISE-R-241) MOBIDIC: A CODE FOR A SIMPLIFIED EVALUATION OF SOME CONTINUOUS AXIAL REFUELLING SCHEMES. Bruschi, C.; Foresti, G.; Pierini, G. (Centro Informazioni Studi Esperienze, Milan (Italy)). Oct 1967. 27p. INIS.

A method is described for a simplified evaluation of three continuous schemes of axial refueling: one-directional, counter-directional and bi-directional refueling. The starting point is the axial one-group diffusion equation, where radial leakage is simulated by a constant buckling. The code needs a table of one-group constants versus irradiation and reflector properties, to be given as input data; it has to be noticed that the only variation with position in the lattice cell proprieties is the one associated with irradiation (e.g., no effects due to coolant density profile are included). The discharge burnup of the fuel and the axial flux distribution are obtained by solving an integral equation iteratively until the core height is matched. The code MOBIDIC, written for the IBM 7040 computer, displays a running time of about 5 sec for the three cycles. (INIS)

55197 (ORNL-4794, pp 96-7) REACTOR EVALUATION STUDIES. Aug 1972.

In Chemical Technology Division annual progress report for period ending March 31, 1972.

Research is reported on: probabilistic simulation of power systems, power systems integration model, and fuel cycle cost code. (D.H.M.)

55198 (ORNL-TM-2496(Rev.2)(Suppl.3)) NUCLEAR REACTOR CORE ANALYSIS CODE: CITATION. Revision 2, Supplement 3. Fowler, T. B.; Vondy, D. R. (Oak Ridge National Lab., Tenn.). Jul 1972. 28p. Dep. NTIS.

Replacement pages are presented for the CITATION code report. The changes and additions reflect additional development of the code since the issue of Supplement 2. (H.D.R.)

Safety and Siting

Refer also to abstract 55375.

55199 (AEC-tr-7319) SOME PROBLEMS OF STUDYING EMERGENCIES IN A NUCLEAR POWER PLANT WITH PRESSURIZED WATER REACTOR. Kuznetsov, V. D. Translated from Kernenergie, 14: 188-90(1971). 6p. Dep. NTIS.

Some problems of analyzing the loss of coolant accident conditions in pressurized water power reactors are described. Inaccuracies caused by excessive simplification of the models in analysis of loss of coolant accidents are discussed. 5 references. (auth)

55200 (COO-2152-4) INVESTIGATION OF PRESSURE DROPS AND HEAT TRANSFER COEFFICIENTS FOR LOSS OF COOLANT EVALUATIONS. Quarterly Progress Report [for] Period Ending June 30, 1972. (Cincinnati Univ., Ohio. Dept. of Chemical and Nuclear Engineering). 1972. Contract AT(11-1)-2152. 11p. Dep. NTIS.

Progress in three areas of water cooled reactor loss of coolant accident evaluations is reported, including: transient pressure drop investigation; two-phase pressure drop and flow pattern study; and transition boiling and reflooding heat transfer tests. (H.D.R.)

55201 (DUN-SA-168) DEVELOPMENT AND IMPLEMENTATION OF EQUIPMENT MAINTENANCE STANDARDS FOR NUCLEAR REACTORS. Clement, T. M. (Douglas United Nuclear, Inc., Richland, Wash.). 13 May 1971. 8p. Dep. NTIS.

A formal system of maintenance standards is necessary to provide the nuclear power industry with factual, quantitative risk evaluations that will guide us in developing simpler and more reliable energy systems. These facts will also help dispel many of the allegations concerning the safety and environmental effects of nuclear power plants. (auth)

55202 (IRS-F-10) REPORT OF RESEARCH ORDERED BY THE FEDERAL MINISTRY FOR CONSTRUCTION AND RESEARCH IN THE FIELD OF REACTOR SAFETY. Quarterly Progress Report, January 1-March 31, 1972. (Technischer Ueberwachungs-Verein e. V., Cologne (West Germany). Institut fuer Reaktorsicherheit). 90p. (In German). Dep. NTIS (U. S. Sales Only).

Short administrative summaries of the various projects related to reactor safety in the Federal Republic of Germany are presented. Project accountability information is included. (J.M.J.)

55203 (JAERI-M-4473) ANALYSIS OF PRESSURE WAVE PROPAGATION IN PIPE RUPTURE ACCIDENTS OF LIGHT-WATER COOLED REACTORS BY USE OF THE BURST CODE. I. WAVE PROPAGATION THROUGH A SINGLE-PHASE FLUID. Shinoda, Wataru; Imaoka, T.; Kawabe, R.; Ishikawa, Michio (Japan Atomic Energy Research Inst., Tokyo). Jun 1971. 106p. (In Japanese). NTIS (U. S. Sales Only).

The pressure wave propagations in various types of flow systems have been studied by using the computational program BURST to obtain information on the applicability and operational techniques of the program. A range of flow systems is covered: a simple cylinder, a pipe with variable flow area (an adapter), an open end, and a simulated boiling water reactor with a flow restrictor in the main steam line. The system is assumed to be filled with single-phase fluid, subcooled water or superheated steam. From this analysis the following was revealed: (1) the calculated results agree well with theoretical predictions for the systems with simple geometries, thus confirming the mathematical model of the program. (2) The shape of the transmitted pressure wave may be distorted while traveling through an adapter with a length comparable with or greater than that of the wave front. (3) The steam flow rate could be limited by the critical phenomenon within the flow restrictor. (auth)

55204 (JAERI-M-4535) STUDY ON THE WORKS OF ENGINEERING REACTOR-SAFETY. Shimamune, Hiroji; Ishikawa, Michio; Sako, Kiyoshi; Shiba, Masayoshi; Tomii, Kakuzo (Japan Atomic Energy Research Inst., Tokyo). Aug 1971. 41p. (In Japanese). NTIS (U. S. Sales Only).

To carry out reactor-safety research works effectively, accident phenomena must be understood systematically in a realistic manner. For this purpose, trees which indicate the sequences of phenomena are made for important credible accidents. Studies are made on the accident trees to have the state of art in safety research experiments and safety analysis codes. Based on these results, the NSRR program being planned in JAERI is re-studied as part of the safety research works. (auth)

55205 (JAERI-Memo-4041) AN EXPERIMENTAL FACILITY TO SIMULATE THE LOSS-OF-COOLANT ACCIDENT OF LIGHT-WATER REACTORS. PART 5. Ikutame, Ken; Ishiguro, Misako (Japan Atomic Energy Research Inst., Tokyo). 1970. 76p. (In Japanese and English). Dep. NTIS (U. S. Sales Only).

Data sheets were assembled to present some of the details of the instrumentation used at the experimental installation built to simulate accidents arising from the loss of reactor coolant. The experimental equipment is described; the 36 tables and figures cover the detection system, auxiliary devices, flow diagrams and charts and operational characteristics. The detection transducer, primary amplifiers, d-c amplifiers used for matching, integrating digital voltmeters, electromagnetic oscilloscope, desk-top recorder and synchroscope, wave-shape generator, automatic voltage regulator, digital data coder, and analog data coder are described more closely, outlining also the operation of thermocouples with the differential amplifier, the quartz pressure transducer, resistance line pressure transducer and the dynamic resistance line strain gage. The off-line equipment mentioned includes the DATAC-2000 and FACOM-230/60 used for electronic data processing. (TTT)

55206 (KFK-1580) CALCULATION OF THE TIME DEPENDENT FISSION PRODUCT HEAT SOURCE STRENGTH IN TWO COUPLED SYSTEMS WITH CONSIDERATION OF FISSION PRODUCT ESCAPE. **Henzel, N.; Simon-Weidner, J.; Walbel, E. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Reaktorentwicklung). Apr 1972. 188p. (In German). Dep. NTIS (U. S. Sales Only).**

The fission product heat source within the oxide fuel of a LWR after a MCA with malfunction of the ECC system is investigated. The calculation of the time dependent heat source includes both radioactive decay and individual escape of fission products which is related to temperature and therefore the structure or the physical state of the fuel. A theoretical investigation of fission product escape coefficients for the elements Se to Eu is described. Results of a literature search on the experimental investigation of fission products escape coefficients are tabulated. An escape model including the necessary escape coefficients is presented. BWR Brunsbüttel and PWR BASF Mitte are used as an example to calculate fission product inventory and decay heat source without and with fission product escape after 1000 days of full power and shutdown. Given are the single nuclides, the chemical elements and the totals. Escaped fission products are released into a second system (outside the fuel), and their decay and increase is calculated separately. The model gives a maximum reduction of the heat source within the fuel by escape of fission products up to 50% of the momentary value. This maximum reduction occurs shortly after fuel melting. Special consideration was given to the time dependent contribution of the single chemical elements (total of the nuclides with the same atomic number) to the heat source. It was found that after more than 6 min after the assumed accident (cladding failure will occur at this time) only Nb, I, La and, after 2 days, Pr will contribute more than 10% to the total decay heat source. The results of the calculations are interpreted and recommendations are given for an experimental program aimed at the investigation of the fission product escape model where it is important to the rest-heat source problem. (auth)

55207 (ORNL-TM-3900) ORNL NUCLEAR SAFETY RESEARCH AND DEVELOPMENT PROGRAM BIMONTHLY REPORT FOR MAY-JUNE 1972. **Cottrell, Wm. B. (Oak Ridge National Lab., Tenn.). Sep 1972. Contract W-7405-eng-26. 144p. Dep. NTIS.**

The accomplishments during the months of May and June in the research and development program are summarized. Much of this work is in general support of water-cooled power reactor technology, including LOFT and industry programs, and reflects current safety problems, such as blow-down heat transfer studies. Several projects are also conducted in support of the high-temperature gas-cooled reactor (HTGR) and the liquid-metal fast breeder reactor (LMFBR) programs. Other major projects include experimental investigations of the attachment of nozzles to shells and the implementation of joint AEC–PVRC programs on heavy-section steel technology and nuclear piping, pumps, and valves. Seismic considerations of particular significance in nuclear plant design are evaluated in the seismic program. Several of the above projects are also directly related to another major undertaking, the AEC's standards program, which entails development of engineering safeguards and the establishment of codes and standards for government-owned or -sponsored reactor facilities. The recent activities of NSIC and the Nuclear Safety journal in behalf of the nuclear community are also discussed. Of particular interest in both of these activities is the recent emphasis on environmental effects. (auth)

55208 (RDT-F-9-1-T(8-72)) REQUIREMENTS FOR NUCLEAR COMPONENTS AT ELEVATED TEMPERATURES (SUPPLEMENT TO ASME ELEVATED TEMPERATURE CODE CASE 1331). **(Division of Reactor Development and Technology (AEC), Washington, D. C.). Aug 1972. 36p. RSO.**

Supplementary information is presented concerning standards for high temperature requirements of Class 1 components for nuclear reactors. (D.C.C.)

55209 (RISO-M-1500) RELY 4: A MONTE CARLO COMPUTER PROGRAM FOR SYSTEM RELIABILITY ANALYSIS. **Kongsoe, H. E. (Danish Atomic Energy Commission, Risoe. Research Establishment). 6 Jun 1972. 78p. Dep. NTIS (U. S. Sales Only).**

A computer program for calculation of reliability and availability of systems is described. The program is written in B6700 ALGOL. The program can be used for reliability analysis of both mechanical, electric and electronic systems, also systems containing standby units. The description consists of a summary, block diagrams and complete listings of the four versions of the program in addition to examples of input and output. There are four versions of the program with different distribution functions for the times to failure and repair times. Two of the versions use variance reduction—importance sampling—and the others, direct simulation. The basic theories and concepts are outlined. 9 references. (auth)

55210 RADIATION SAFETY OF NUCLEAR POWER PLANTS. **Melichar, Zdenek; Hladky, Eduard. Jad. Energ.; 18: No. 7, 217-24(Jul 1972). (In Czech).**

The problems of radiation safety in connection with atomic electric power stations were examined. For the proposed development of Czech nuclear energy a general program of research and development was developed. The necessity of a complex approach to a solution of radiation safety of nuclear power plants is emphasized, and basic fields of application of the results are demonstrated. (tr-auth)

55211 NUCLEAR POWER STATIONS. THE DIFFERENT TYPES OF REACTOR. THE PRINCIPAL TYPES OF ACCIDENT WHICH CAN OCCUR DURING OPERATION. **Teste du Bailler, A. (Electricite de France, Saint-Denis). Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.): No. 91, 13-17(Sep 1971). (In French).**

Reactors are classified in terms of the nature of the fuel-moderator system. The laws concerning the compatibility of the two materials are physical (neutronic-thermal), physicochemical (corrosion), and technological or economic (costs-supplies). The existing different types of reactor are reviewed: CGR, AGR, HTR, HWR, PWR, BWR (light water) and fast reactors. A classification of accidents (or serious incidents) according to their causes is proposed: power excursions, accidents involving fuel, and accidents affecting the structures. (France)

Steam and Power Conversion System

55212 (CONF-720925-2) URBAN UTILIZATION OF EXTRACTED HEAT AND WASTE HEAT FROM CENTRAL STATION POWER PLANTS. **Beall, Sam E. Jr.; Miller, Arthur J. (Oak Ridge National Lab., Tenn.). [nd]. 20p. Dep. NTIS.**

From seventh intersociety energy conversion engineering conference; San Diego, CA. (25 Sep 1972).

An analysis is presented of the feasibility of providing thermal energy as well as electricity to urban areas from central station steam-electric power plants. Consideration is given to the use of thermal energy for applications such as industrial processes, building space heating, air conditioning, sewage treatment, agriculture, and aquaculture. The analysis shows that the use of dual-purpose plants significantly reduces the consumption of fuel and lessens the environmental impact of providing energy as compared to conventional systems. Areas of multifamily dwellings and other multistoried buildings could be served in new cities, or renewed old cities, at costs comparable to those incurred with more conventional separate systems. However, it would require more planning of facilities and coordination of diverse organizations than we normally employ. The costs and dislocations associated with retrofitting existing cities would cause each city to be a separate case. (9 references) (auth)

Commercial Power Reactors

55213 (FIND-50390(8-72)) FIND: WATTS BAR NUCLEAR PLANT, UNITS 1 AND 2. **Smith, James G. (ed.) (Technical Information Center (AEC), Oak Ridge, Tenn.). 31 Aug 1972. 18p. (FIND-50391(8-72)). Dep. NTIS.**

An index to microfiche issuances of safety analysis reports is provided. Subject citations are to specific frames on the microfiche. (J.M.J.)

55214 (WASH-1208(9-72)) STATUS OF CENTRAL STATION NUCLEAR POWER REACTORS SIGNIFICANT MILESTONES.

(Division of Reactor Development and Technology (AEC), Washington, D. C.). 1 Sep 1972. 9p. Dep. NTIS.

A table listing all constructed, contracted, and planned nuclear power plants in the U.S. is presented. Included in the table are the names and location of the reactors, electric output, type of reactor, steam system suppliers and architect–engineers, and pertinent dates. (J.M.J.)

55215 GANGES OF THE DESERT: RAJASTAN ATOMIC POWER PROJECT. Gupta, Veerendrakumar (Rajastan Atomic Power Project, Kota, India). Vaigyanik; 3: No. 1, 5-7; 21(Mar 1971). (In Hindi).

The Rajastan Atomic Power Plant will be put into operation at Rawatbhata about 40 miles from Kota in Rajastan. It will have two Candu-type 200-MW reactors, using heavy water as moderator and coolant. The main reactor dome is a 4 ft thick concrete wall and can stand a pressure of 6 lb/in^2 inside the dome. The major reactor equipment such as calandria, dump tank, shield tank, coolant channel assemblies, and auxiliary reactor equipment such as the fueling machine carriage, dousing water tank, etc., will be housed inside the dome. The turbogenerator set and instrumentation and control equipment will be installed in a separate building. Gaseous radioactive wastes will be disposed of through a 300 ft. high stack. Every precaution was taken to reduce accidents to an absolute minimum. (INIS)

55216 SPEEDY ADVANCE OF CONSTRUCTION IN ATUCHA. Gerwin, R. Deut. Forschungsdienst, Sonderber. Kernenerg.; 15: No. 15, 77-8(1970). (In German).

A report is given about the status of construction work on the Atucha reactor followed by a preview of future work. The shell construction by 1970 and operational tests are due to begin in mid 1972. (INIS)

Control and Instrumentation

55217 (BAW-10047(Rev.1)) STUDY OF DISCONTINUITIES IN CONTROL ROD DRIVE MOTOR TUBE EXTENSIONS. Johnson, T. O.; Ayres, P. S.; Echelbarger, G. J.; Lawrie, W. E. (Babcock and Wilcox Co., Lynchburg, Va. (USA). Nuclear Power Generation Div.). Aug 1972. 77p.

Some control rod drive motor tube extensions have exhibited variations in wall thickness and discontinuities on the inner surface of the tube. An extensive investigation of these conditions is discussed. A program for resolving the findings is described. (auth)

55218 (EURFNR-976) CLADDING CONTROL ON NUCLEAR REACTOR FUEL ELEMENTS. Jacobi, S.; Tradowsky, K. (Kernforschungszentrum, Karlsruhe (West Germany). Labor fuer Elektronik und Messtechnik). Translation of report KFK-1452. 11p. Dep. NTIS.

Work performed under United States–Euratom Fast Reactor Exchange Program.

The problem of release of fission products and of fuel material into the coolant is discussed. The operation of failed fuel element detection devices is explained. For water-cooled reactors, the method of precipitation of solid fission products is described. In sodium-cooled reactors, the relative low activity of the fission products must be discriminated from the very high activity of the sodium. This is possible by measuring the delayed neutron emission of some fission products. (12 references) (auth)

55219 (RDT-C-7-18-T(8-72)) THERMOWELL SYSTEMS FOR LIQUID METAL SERVICE. (Division of Reactor Development and Technology (AEC), Washington, D. C.). Aug 1972. 22p. RSO.

This standard covers design and fabrication requirements for thermowell systems for installation in piping or vessels in liquid metal systems. These thermowell systems include a thermocouple or a resistance temperature detector (RTD), a thermowell, tip, extension tube, and connection head. (auth)

Containment Systems, Waste Processing, and Radiation Protection

55220 (BNL-16965) REACTOR EFFLUENTS: AS LOW AS PRACTICABLE OR AS LOW AS REASONABLE. Hull, Andrew P. (Brookhaven National Lab., Upton, N. Y.). 1972. 25p. (CONF-720614-1). Dep. NTIS.

From 17th annual meeting of the Health Physics Society; Las Vegas, NV. (12 Jun 1972).

Recent amendments proposed by the U.S. Atomic Energy Commission to 10CFR50, set forth numerical guides to keep radioactivity in light-water-cooled nuclear power reactors as low as practicable. These are intended to restrict the exposures of nearby persons to 1% or less of the current limits to individuals in the general public. For the most part the amendments contain "across the board" concentration limits, primarily based on their technical practicability. These are radiologically questionable, insofar as they are not related to a projected dose to an individual with reference to specific nuclides, and they are not detectable by straightforward environmental sampling and analysis techniques. The proposed 1% limits in radiation exposures from power reactor effluents are lacking in scientific warrant insofar as the calculated risk related to current reactor effluents is insignificant, relative to other sources of exposure and other kinds of environmental hazards. If adopted, they would occasion a projected expenditure of from $\$3 \times 10^4$ to $\$1 \times 10^6$ per man-rem saved, which is shown to be excessive on several cost-benefit comparisons. Design guides for reactor effluent releases based on 10% of current standards would appear adequate to achieve the AEC's intent. To remove public misunderstanding of the possible total population exposure from the operation of nuclear reactors, a population dose limit of 0.017 rem/year to be specifically apportioned to such operation and related activities is also proposed. (auth)

55221 (NP-19338(Vol.1)) IN-SERVICE INSPECTION PROGRAM FOR NUCLEAR REACTOR VESSELS. [VOLUME] I. Biannual Progress Report No. 6, March 1, 1971–September 1, 1971. (Southwest Research Inst., San Antonio, Tex.). 7 Jan 1972. 159p.

Technical Report to Steering Committee, EEI Project RP 79, Edison Electric Institute/Tennessee Valley Authority.

Progress is reported on the development of methods for in-service inspection of power reactor pressure vessels. Electric utility experience with pressure boundary inspection regarding service condition, defect detection capability, defect size, and defect orientation is reviewed. A facility for the evaluation of a nondestructive test method is described. An acoustic emission system for continuous monitoring for defects is evaluated. (J.M.J.)

55222 (NP-19338(Vol.2)) IN-SERVICE INSPECTION PROGRAM FOR NUCLEAR REACTOR VESSELS. [VOLUME] 2. Biannual Progress Report No. 6, March 1, 1971–September 1, 1971. (Southwest Research Inst., San Antonio, Tex.). 7 Jan 1972. 202p.

Technical Report to Steering Committee, EEI Project RP 79, Edison Electric Institute/Tennessee Valley Authority.

Progress is reported on the development of methods for in-service inspection of power reactor pressure vessels. Areas covered in Vol. 2, a continuation of Vol. 1 (abstracted separately) include improvement in reliability and reproducibility of conventional ultrasonic systems, and investigation of ultrasonic halography for visualization of flaws in thick-walled pressure vessels. (auth)

55223 (WCAP-7870) NEUTRON SHIELDING PADS. Kraus, S. (Westinghouse Electric Corp., Pittsburgh, Pa. Nuclear Energy Systems Div.). May 1972. 44p.

As part of the continuing effort to simplify the core support structure and save construction and assembly time, a design study was conducted to investigate the possibility of replacing the thermal shield with locally positioned plate members, called neutron shielding pads. The plot of the circumferential fluence distribution on the vessel, which is very localized, indicated that this was a practical approach. The design study described in this report established the feasibility of replacing the thermal shield with a series of plate members of equivalent thickness attached to the core barrel by pins and bolts. Both analytical and experimental methods were utilized to determine design adequacy. (auth)

55224 LAYOUT AND FABRICATION OF STEEL REACTOR PRESSURE VESSELS. Bonka, H. Aachen; Technische Hochschule (1971). 25p. (In German).

Thesis.

A brief survey is given of the layout of pressure vessel for 1,200-MW(e) LWRs, selection of materials, permissible strains, wall thickness, and welding methods for the fabrication process. (GF)

Coolant System

55225 (BAW-10050) EVALUATION OF OCONEE REACTOR COMPONENT FAILURE. (Babcock and Wilcox Co., Lynchburg, Va. (USA). Nuclear Power Generation Div.). Sep 1972. 41p.

An investigation was conducted to evaluate the failure of certain Oconee 1 reactor components during hot functional tests in early 1972. (auth)

55226 (CONF-710959–, Paper 4) CLEANUP SYSTEM FOR PRIMARY COVER GAS OF LMFBR. Barulli, L.; Bruzzi, L.; Cicognani, G. (CNEN, Bologna). 15p.

From Meeting on fission and corrosion product behaviour in primary systems of LMFBR's; Bensberg, Germany (20 Sep 1971).

The technical feasibility of a Clean-up System for the cover gas primary system of a LMFBR model similar to FERMI Fast Breeder Reactor is shown. From an economic stand point this type of clean up system is feasible because its estimated cost is only about 1% of the total plant cost. (auth)

55227 (EURFNR-1000) RESULTS OF HEAT TRANSFER AND PRESSURE LOSS MEASUREMENTS WITH HELIUM ON A SIXTEEN-TUBE BUNDLE. Marek, J.; Maulbach, K. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). Translation of report KFK-1549. 43p. Dep. NTIS.

Work Performed under United States-Euratom Fast Reactor Exchange Program.

Measurements of pressure drop and heat transfer of helium at a pressure of 43 atm flowing through a bundle of 16 tubes in a square arrangement are reported. The tubes were heated directly by dc; the heating power was between 110 and 295 kW corresponding to a power of 40-105 W/cm at the heating tube. The tubes were smooth and arranged in a smooth square channel at a distance ratio of p/d = 1.283. The Reynolds numbers ranged between $1.5 \cdot 10^4$ and $1.4 \cdot 10^5$. Wall temperatures up to 550°C have been measured. The isothermal friction coefficients of the entire bundle, including the channel wall, were determined to be about 2% higher than that of the circular tube. The Nusselt numbers for the central channel are slightly smaller than the comparable values of circular tubes. (14 references) (auth)

55228 (JAERI-Memo-4016) RESULTS OF CYCLIC PRESSURE LOADING TEST DUE TO JPDR PRESSURE VESSEL MODEL NO. 2. Fujimura, Tadato; Miyazono, Shohachiro; Ueda, Shuzo; Namatame, Hiroshi; Sakamoto, Fumio; Kadaira, Tsuneo; Shibata, Katsuyuki; Oba, Toshihito; Suzuki, Komei (Japan Atomic Energy Research Inst., Tokyo). May 1970. (In Japanese). NTIS (U. S. Sales Only).

The test program on JPDR pressure vessel model 2 was performed to investigate propagation through base metal for the case where the cladding cracks occur at the location of highest stress in the vessel, that is the nozzles for forced circulation. Strain distribution was measured around nozzles without and with artificial notches. After static strain measurements, the model was loaded by cyclic pressure and investigated for fatigue crack propagation from artificial notch tips. (auth)

Fuels and Fuel Elements

55229 (EURFNR-975) CRITERIA FOR DIFFERENTIATING FUEL AND PLENUM FAULTS ON REACTOR FUEL ELEMENTS WITH VIBROCOMPACTED FUEL. Golly, W.; Jacobi, S. (Kernforschungszentrum, Karlsruhe (West Germany). Labor fuer Elektronik und Messtechnik). Translation of report KFK-1348. 44p. Dep. NTIS.

Work performed under United States-Euratom Fast Reactor Exchange Program.

For research with failed fuel elements the HSD-Loop was installed at the FR 2. The operation with two pins of the HDR-type is described. The pins were failed in the fuel region and at the plenum resp. Criteria are specified to discriminate these two types of defect by means of a precipitator. (10 references) (auth)

Auxiliary Systems and Engineered Safeguards

55230 INCIDENT OF OCTOBER 17, 1969 WITH SAINT-LAURENT-1. POLLUTION OF THE REACTOR AND THE MODIFICATION OF THE FEDAL SYSTEM. Grauvogel, M. A.; Le Noc, J. F. (Electricite de France, Saint-Laurent-des-Eaux). Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.); No. 92, 23-38 (Nov 1971). (In French).

The essential problems which arose with the FEDAL system when the Saint-Laurent-1 reactor was restarted after the incident of October 17, 1969 are examined. The effect of the contaminating uranium dusts on the failed element detection system (FEDAL) are discussed. The various tests, analyses, and experimental measurements performed in order to estimate the quantity of uranium dispersed inside the core are presented. The modifications introduced into the FEDAL system (addition of an individualized FEDAL system to the existing system) and the new programming and data processing systems are described. The results obtained since the restart of the reactor and the subsequent operational difficulties are reviewed. (France)

Operation and Economics

55231 (DOCKET-50003-124) INDIAN POINT STATION, UNIT 1. Malfunction of Main Steam Stop Valve. (Consolidated Edison Co. of New York, Inc., New York). 6 Sep 1972. 4p. Dep. NTIS.

55232 (DOCKET-50003-125) INDIAN POINT STATION, UNIT 1. Reiteration of Request for Six-Month Test of High Pressure Boron Injection Pumps. (Consolidated Edison Co. of New York, Inc., New York). 14 Sep 1972. 3p. Dep. NTIS.

55233 (DOCKET-50016-170) ENRICO FERMI ATOMIC POWER PLANT, UNIT 1. Report for June 1972. (Power Reactor Development Co., Detroit, Mich.). Jun 1972. 14p. (PRDC-EF-106). Dep. NTIS.

55234 (DOCKET-50029-199) YANKEE NUCLEAR POWER STATION. Modification of Approved Change 97 Accomplished August 30, 1972. (Yankee Atomic Electric Co., Westboro, Mass.). 31 Aug 1972. 2p. Dep. NTIS.

The turbine trip requirements related to the revised trip level for low flow conditions in the cooling system are described. (D.C.C.)

55235 (DOCKET-50029-201) YANKEE NUCLEAR POWER STATION. March 1972 Inservice Examination of Yankee Rowe Atomic Power Plant. (Southwest Research Inst., San Antonio, Tex.). Jun 1972. 311p. Dep. NTIS.

For Yankee Atomic Electric Co., Westboro, Mass.

55236 (DOCKET-50029-202) YANKEE NUCLEAR POWER STATION. Control Rod Drop Times Measured on September 9, 1972. (Yankee Atomic Electric Co., Westboro, Mass.). 11 Sep 1972. 1p. Dep. NTIS.

55237 (DOCKET-50155-123) BIG ROCK POINT NUCLEAR PLANT. Apparent Deficiency in Off-Gas Holdup Line. (Consumers Power Co., Jackson, Mich.). 1 Sep 1972. 3p. Dep. NTIS.

55238 (DOCKET-50171-106) PEACH BOTTOM ATOMIC POWER STATION, UNIT 1. Semiannual Operations Report 66, January 1, 1972-June 30, 1972. (Philadelphia Electric Co., Pa.). 6 Sep 1972. 60p. Dep. NTIS.

55239 (DOCKET-50206-167) SAN ONOFRE NUCLEAR GENERATING STATION, UNIT 1. Unit Trip and Subsequent Activation of Safety Injection Equipment. (Southern California Edison Co., Rosemead, Calif.). 31 Aug 1972. 4p. Dep. NTIS.

55240 (DOCKET-50213-157) HADDAM NECK PLANT, UNIT 1. Operational Environmental Radiation Monitoring Program, January 1, 1972-June 30, 1972. (Interex Corp., Waltham, Mass. (USA)). 31 Aug 1972. 30p. Dep. NTIS.

For Connecticut Yankee Atomic Power Co., Haddam.

55241 (DOCKET-50213-158) HADDAM NECK PLANT, UNIT 1. Containment Testing June 1970-June 1972. (Connecticut Yankee Atomic Power Co., Haddam). 8 Sep 1972. 32p. Dep. NTIS.

55242 (DOCKET-50219-213) OYSTER CREEK NUCLEAR POWER PLANT, UNIT 1. Report of Operations, Semiannual Report 6, January 1, 1972-June 30, 1972. (Jersey Central Power and Light Co., Morristown, N. J.). 31 Aug 1972. 67p. Dep. NTIS.

55243 (DOCKET-50237-257) DRESDEN NUCLEAR POWER STATION, UNITS 2 AND 3. Two EHC Oil Low Pressure Scram Switches Setpoints Drifted Beyond Established Limits. (Commonwealth Edison Co., Chicago, Ill.). 23 Aug 1972. 2p. (DOCKET-50249-154). Dep. NTIS.

55244 (DOCKET-50237-258) DRESDEN NUCLEAR POWER STATION, UNIT 2. Low Flow on "B" Steam Line. (Commonwealth Edison Co., Chicago, Ill.). 7 Sep 1972. 2p. Dep. NTIS.

55245 (DOCKET-50244-118) ROBERT EMMETT GINNA NUCLEAR POWER PLANT, UNIT 1. Monthly Report of Activity Measurements. (Rochester Gas and Electric Corp., N. Y.). 6 Sep 1972. 2p. Dep. NTIS.

55246 (DOCKET-50245-158) MILLSTONE POINT NUCLEAR POWER STATION, UNIT 1. Environmental Radiation Survey Program, Semiannual Report, January 1, 1972-June 30, 1972. (Interex Corp., Waltham, Mass. (USA)). 31 Aug 1972. 45p. Dep. NTIS.

For Millstone Point Co., Hartford, Conn.

55247 (DOCKET-50249-155) DRESDEN NUCLEAR POWER STATION, UNIT 3. Two Incidents. (Directorate of Licensing (AEC), Washington, D. C.). 11 Sep 1972. 1p. Dep. NTIS.

An incorrect set point for electrohydraulic control low oil pressure scram switches is described. The malfunction of a turbine control valve to indicate a half scram when fast closed is discussed. (D.C.C.)

55248 (DOCKET-50250-92) TURKEY POINT PLANT, UNITS 3 AND 4. Abnormal Occurrence No. 3-72-5. (Florida Power and Light Co.). 1 Sep 1972. 2p. (DOCKET-50251-76). Dep. NTIS.

Information is presented concerning the failure of the valve stem packing on the gate valve in the suction line from the residual heat removal system to the cooling system. (D.C.C.)

55249 (DOCKET-50250-94) TURKEY POINT PLANT, UNITS 3 AND 4. Three Unusual Events, August 12 and August 21, 1972. (Florida Power and Light Co.). 8 Sep 1972. 2p. (DOCKET-50251-77). Dep. NTIS.

The unplanned simultaneous actuation of the safety injection systems for Units 3 and 4 is described during the scheduled actuation of the Unit 4 system. The packing failure for the 3A charging pump is discussed. The failure of the emergency diesel generator to produce a required test output is described. (D.C.C.)

55250 (DOCKET-50254-117) QUAD-CITIES STATION, UNIT 1. Valves in the "RCIC" System Failed to Operate on September 3, 1972. (Commonwealth Edison Co., Cordova, Ill.). 4 Sep 1972. 1p. Dep. NTIS.

55251 (DOCKET-50255-99) PALISADES PLANT. Four Control Rods Failed to Drop on Routine Test. (Consumers Power Co., Jackson, Mich.). 8 Sep 1972. 3p. Dep. NTIS.

55252 (DOCKET-50261-109) H. B. ROBINSON UNIT 2. Malfunction of Part Length Rod Control System. (Carolina Power and Light Co., Raleigh, N. C.). 11 Sep 1972. 1p. Dep. NTIS.

55253 (DOCKET-50263-149) MONTICELLO NUCLEAR GENERATING PLANT, UNIT 1. Six Month Operating Report No. 3, January 1, 1972-June 30, 1972. (Northern States Power Co., Minneapolis, Minn.). 1972. 132p. Dep. NTIS.

55254 (DOCKET-50265-115) QUAD-CITIES STATION, UNIT 2. Seven Valves Failed to Test Properly on Routine Inspection. (Commonwealth Edison Co., Cordova, Ill.). 6 Sep 1972. 3p. Dep. NTIS.

The failure of seven suppression chamber to drywell vacuum breaker valves to operate during a routine inspection test is described. Corrective actions are discussed. (D.C.C.)

55255 (DOCKET-50271-100) VERMONT YANKEE NUCLEAR POWER STATION. Offsite Environmental Radiological Monitoring Report, January 1, 1972-June 30, 1972. (Vermont Yankee Nuclear Power Corp., Rutland). 6 Sep 1972. 13p. Dep. NTIS.

55256 (DOCKET-50271-101) VERMONT YANKEE NUCLEAR POWER STATION. Facility Operating License DPR-28, Amendment 2 (Temporary Operating License). (Directorate of Licensing (AEC), Washington, D. C.). 8 Sep 1972. 12p. Dep. NTIS.

55257 (DOCKET-50280-83) SURRY POWER STATION, UNIT 2. Returned to Service on September 3, 1972. (Virginia Electric and Power Co., Richmond). 5 Sep 1972. 2p. Dep. NTIS.

55258 (DOCKET-50282-74) PRAIRIE ISLAND NUCLEAR GENERATING PLANT, UNIT 1. Interim Report on Deficient Motor Operated Valve Torque Switches. (Northern States Power Co., Minneapolis, Minn.). 30 Jun 1972. 2p. Dep. NTIS.

55259 (DOCKET-50333-53) JAMES A. FITZPATRICK NUCLEAR POWER PLANT. Amended and Substituted Application for Licenses, Amendment 12. (Power Authority of the State of New York). 6 Sep 1972. 109p. Dep. NTIS.

Financial data on the owners of the James A. Fitzpatrick Power Reactor are presented. The 1971 Annual Reports for the Power Authority of the State of New York and the Niagara Mohawk Power Corporation are included. (D.C.C.)

55260 (DOCKET-50382-36) WATERFORD STEAM ELECTRIC STATION, UNIT 3. Preliminary Safety Analysis Report, Amendment 22. (Louisiana Power and Light Co., New Orleans). 28 Aug 1972. 100p. Dep. NTIS.

Financial data on the owners of the Waterford Power Reactor Unit 3 are presented. The 1970 and 1971 Annual Reports for the Louisiana Power and Light Company are included. (D.C.C.)

55261 (DOCKET-50397-27) HANFORD NO. 2 NUCLEAR POWER PLANT. Preliminary Safety Analysis Report, Amendment 13. (Washington Public Power Supply System, Richland). 14 Sep 1972. 5p. Dep. NTIS.

Revised information is presented concerning construction costs for the Hanford Power Reactor Unit 2. (D.C.C.)

55262 (DOCKET-50400-23) SHEARON HARRIS NUCLEAR POWER PLANT, UNITS 1, 2, 3, AND 4. License Application, Amendment 14. (Carolina Power and Light Co., Raleigh, N. C.). 31 Aug 1972. 62p. (DOCKET-50401-23; DOCKET-50402-23; DOCKET-50403-23). Dep. NTIS.

Financial data on the owners of the Shearon Harris Power Reactor Units 1, 2, 3, and 4 are presented. The 1971 Annual Report for the Carolina Power and Light Company is included. (D.C.C.)

55263 (DOCKET-50404-24) NORTH ANNA POWER STATION, UNITS 3 AND 4. License Application, Amendment 9. (Virginia Electric and Power Co., Richmond). 13 Sep 1972. 78p. (DOCKET-50405-24). Dep. NTIS.

Financial data on the owners of the North Anna Power Reactor Units 3 and 4 are presented. The 1971 Annual Report of the Virginia Electric and Power Company is included. (D.C.C.)

55264 (JAERI-Memo-4083) NUCLEAR FUEL BALANCE CALCULATION AT JPDR. Ezure, H.; (and others) (Japan Atomic Energy Research Inst., Tokyo). Jul 1970. (In Japanese). NTIS (U. S. Sales Only).

The material balance of the nuclear fuel of JPDR is calculated during the operation time from the initial start-up to JPDR-I operation end using a three-dimensional boiling water reactor simulator code FLARE and a newly coded three-dimensional burn-up code TERA. An outline of the calculations is presented. (auth)

55265 (ORNL-TM-3743) ORCOST: A COMPUTER CODE FOR SUMMARY CAPITAL COST ESTIMATES OF STEAM-ELECTRIC POWER PLANTS. USER'S MANUAL. Fuller, L. C.; Sweet, C. A.; Bowers, H. I. (Oak Ridge National Lab., Tenn.). Sep 1972. Contract W-7405-eng-26. 83p. Dep. NTIS.

ORCOST is a digital computer program for estimating direct and indirect capital costs of nuclear and fossil-fueled steam-electric power plants. The costs are calculated using base cost models which are included in the program for each of the following types of plants: PWR, BWR, HTGR, coal, gas, and oil. The code follows the guidelines of AEC Report NUS-531. The computer output includes a summary of input data and the calculated costs. (4 references) (auth)

55266 (RD/B/N-2261) RELP VERSION C: A REACTOR ECONOMICS LINEAR PROGRAM FOR THE IBM 360/85 COMPUTER. Draper, J. M.; Jones, P. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Jun 1972. 31p. Dep. NTIS (U. S. Sales Only).

A users' guide is provided to the computer code RELIP which uses a linear programming technique to calculate the optimum mix of station types in a nuclear generating system in order to minimize the total system cost. The code was written to study, for example, the consequences of design changes of the fuel rating or burn-up on the fabrication, reprocessing, separative work and ore requirements of the system. Details of the input requirements are given together with an outline of the costing calculations and a sample run. (auth)

55267 (WASH-1139(Rev.1)) GROWTH OF NUCLEAR POWER, 1972-1985. (Office of Planning and Analysis (AEC), Washington, D. C.). Dec 1971. 18p. Dep. GPO $0.30.

An updated forecast of nuclear power growth in the United States and the rest of the free world is presented principally for use in AEC production planning. This forecast updates information provided in WASH-1139, the AEC's 1970 forecast, and reflects current consideration of domestic and foreign nuclear power growth, foreign enrichment capabilities in the future and the timing of the application of plutonium recycle technology. The nuclear generating capacities in this forecast have been translated into demands for uranium feed and separative work by use of the known and expected characteristics of nuclear reactors. (auth)

55268 GENTILLY GEARS FOR FULL NUCLEAR POWER. Mod. Power Eng.: 66: No. 5, 66-7(May 1972).

The prototype CANDU (natural-uranium fuelled, heavy-water moderated) reactor at Gentilly, Quebec, is the first of its kind to be cooled by boiling light water. The Gentilly reactor was built by Hydro-Quebec, who will eventually buy it from Atomic Energy of Canada Limited. During the commissioning period following criticality in November 1970, there was trouble with tilting of the axis of neutron flux, necessitating restriction of power to 50% of the maximum 250 MW, and care in the use of enriched booster fuel rods. In the spring of 1972, power was at 75% of capacity, before increase to full power in the summer. During a shutdown in May 1971, repairs were done to the coolant system, and in

February 1972, shutdown-initiating devices for protection against "tilt" were installed. A dual digital computer system is used for acquisition, display, and logging of data, and for controlling power, steam-drum levels, moderator level, and the fueling machine. (Canada)

55269 WYLFA NUCLEAR POWER STATION. Nucl. Eng. Int.; 17: No. 193, 479-80(Jun 1972).

The successful operation of Wylfa Nuclear Station during the first 18 months is briefly outlined. Notable achievements were high stability of control of the boilers, exceptional fuel performance, and success of the more compact on-line computer control system. The extreme dryness of the gas circuit is especially significant in relation to the maximum temperature imposed as a result of CO_2 corrosion problems in earlier reactors, and there is reasonable expectation that eventually the full design power of 1100 MW(e) will be achieved. (UK)

55270 SPECIAL PROJECTS TEAM AT OLDBURY. Elec. Times; 161: No. 25, 43-4(22 Jun 1972).

Examples are given of the work performed by the special project team formed to modify and develop the nuclear station at Oldbury, to give improved availability. Factors contributing to the original low availability and the steps taken that caused an improvement from 61 to 86% between 1968 and 1971 are discussed. (UK)

Safety and Siting

Refer also to abstracts 53182–53185 and 53511.

55271 (BAW-10034(Suppl.1)) MULTINODE ANALYSIS OF B AND W'S 2568-MWt NUCLEAR PLANTS DURING LOSS-OF-COOLANT ACCIDENT. Parks, C. E.; Dunn, B. M.; Jones, R. C. (Babcock and Wilcox Co., Lynchburg, Va. (USA). Nuclear Power Generation Div.). Aug 1972. 23p.

A guillotine break of the line connecting the core flooding tank to the reactor vessel between the vessel's nozzle and the first check valve is analyzed at power levels of 2568 and 2772 MW(t). All conditions of the AEC Interim Acceptance Criteria are met. (auth)

55272 (BAW-10048(Suppl.1)) MULTINODE ANALYSIS OF B AND W'S 145-FUEL ASSEMBLY NUCLEAR PLANTS DURING LOSS-OF-COOLANT ACCIDENT. Parks, C. E.; Allen, R. J.; Schermer, W. J. (Babcock and Wilcox Co., Lynchburg, Va. (USA). Nuclear Power Generation Div.). Aug 1972. 19p.

An analysis of the double-ended break of the pipe that connects a core flood tank to the reactor vessel at a point between the reactor vessel core flooding line nozzle and the first upstream check valve in the flooding line is presented. 4 references. (auth)

55273 (DOCKET-1151–58) ELK RIVER REACTOR. Sixth Report on Status of Deactivated Reactor. (United Power Association, Elk River, Minn. (USA)). 30 Aug 1972. Contract AT-(11-1)-651. 8p. Dep. NTIS.

55274 (DOCKET-50010–117) DRESDEN NUCLEAR POWER STATION, UNITS 1, 2, AND 3. QUAD-CITIES STATION, UNITS 1 AND 2. ZION STATION NUCLEAR POWER PLANT, UNITS 1 AND 2. Valve Wall Thickness. (Directorate of Regulatory Operations (AEC), Glen Ellyn, Ill. Region III). 13 Sep 1972. 7p. (DOCKET-50237–259; DOCKET-50249–156; DOCKET-50254–121; DOCKET-50265–116; DOCKET-50295–62; DOCKET-50304–62). Dep. NTIS.

55275 (DOCKET-50029–200) YANKEE NUCLEAR POWER STATION. Flooding of Critical Equipment. (Directorate of Licensing (AEC), Washington, D. C.). 8 Aug 1972. 4p. Dep. NTIS.

The possible flooding of engineered safeguard equipment due to failure of the circulating water system is analyzed. (D.C.C.)

55276 (DOCKET-50146–111) SAXTON NUCLEAR EXPERIMENTAL REACTOR PROJECT. License DPR-4, Amendment 8. (Directorate of Licensing (AEC), Washington, D. C.). 15 Aug 1972. 30p. Dep. NTIS.

Approved technical specifications related to a reduction in surveillance and staffing for the decommissioning of the Saxton Power Reactor are presented. (D.C.C.)

55277 (DOCKET-50155–124) BIG ROCK POINT NUCLEAR PLANT. Equipment Failure, July 29, 1972. (Consumers Power Co., Jackson, Mich.). 13 Sep 1972. 1p. Dep. NTIS.

The failure of both neutron monitoring startup channels of the Big Rock Point Power Reactor is reported. (H.D.R.)

55278 (DOCKET-50155–125) BIG ROCK POINT NUCLEAR PLANT. PALISADES PLANT. Valve Wall Thickness. (Directorate of Regulatory Operations (AEC), Glen Ellyn, Ill. Region III). 13 Sep 1972. 6p. (DOCKET-50255–100). Dep. NTIS.

55279 (DOCKET-50245–159) MILLSTONE POINT NUCLEAR POWER STATION, UNIT 1. Application for Conversion from Provisional Operating License to Full-Term Operating License. (Millstone Point Co., Hartford, Conn.). 1 Sep 1972. 327p. Dep. NTIS.

55280 (DOCKET-50245–160) MILLSTONE POINT NUCLEAR POWER STATION, UNIT 1. Abnormal Occurrences Nos. 72-21 and 72-22. (Millstone Point Co., Hartford, Conn.). 11 Sep 1972. 3p. Dep. NTIS.

The occurrence of a reactor coolant leakage rate into the primary containment in excess of the allowable rate and of abnormal reactor coolant chemistry limits are reported for the Millstone Point Power Reactor, Unit 1. (H.D.R.)

55281 (DOCKET-50247–81) INDIAN POINT NUCLEAR GENERATING UNIT 2. Order Extending Construction Completion Date to January 2, 1973. (Directorate of Licensing (AEC), Washington, D. C.). 18 Sep 1972. 2p. Dep. NTIS.

55282 (DOCKET-50250–93) TURKEY POINT PLANT, UNIT 3. Technical Specifications, Change 1. (Directorate of Licensing (AEC), Washington, D. C.). 6 Sep 1972. 2p. Dep. NTIS.

Revised technical specifications are presented concerning a reduction in the power tilt limits. (D.C.C.)

55283 (DOCKET-50254–118) QUAD-CITIES STATION, UNITS 1 AND 2. Technical Specifications, Outstanding Items. (Commonwealth Edison Co., Chicago, Ill.). 31 Aug 1972. 5p. (DOCKET-50265–112). Dep. NTIS.

Requested information is presented concerning technical specifications. (D.C.C.)

55284 (DOCKET-50254–119) QUAD-CITIES STATION, UNITS 1 AND 2. Answers to AEC Questions Regarding Condensate Pump Room Flooding. (Commonwealth Edison Co., Chicago, Ill.). 1 Sep 1972. 9p. (DOCKET-50265–113). Dep. NTIS.

55285 (DOCKET-50254–120) QUAD-CITIES STATION, UNITS 1 AND 2. Final Environmental Statement. (Directorate of Licensing (AEC), Washington, D. C.). Sep 1972. 351p. (DOCKET-50265–114). Dep. NTIS.

Information concerning chemical, radioactive, and thermal discharges from the reactors is presented. The effects of reactor operations on the environment are analyzed. Ecological, hydrological, and meteorological data on the reactor site are included. Cost-benefit analysis for reactor operations is presented. (D.C.C.)

55286 (DOCKET-50261–106) H. B. ROBINSON UNIT 2. Final Facility Description and Safety Analysis Report, Volume 3. (Carolina Power and Light Co., Raleigh, N. C.). 26 Nov 1968. 731p. Dep. NTIS.

Information is presented on the H. B. Robinson Power Reactor Unit 2 under the following broad topics: electrical systems; auxiliary and emergency systems; steam and power conversion systems; radioactive waste systems; radiation protection systems; operations; initial tests; and safety analysis. (D.C.C.)

55287 (DOCKET-50261–108) H. B. ROBINSON UNIT 2. Technical Specifications, Change. (Carolina Power and Light Co., Raleigh, N. C.). 8 Sep 1972. 2p. Dep. NTIS.

Revised technical specifications are presented concerning performance requirements of the emergency core cooling system. (D.C.C.)

55288 (DOCKET-50263–150) MONTICELLO NUCLEAR GENERATING PLANT, UNIT 1. Valve Wall Thickness. (Directorate of Regulatory Operations (AEC), Glen Ellyn, Ill. Region III). 13 Sep 1972. 7p. Dep. NTIS.

55289 (DOCKET-50266–79) POINT BEACH NUCLEAR PLANT, UNITS 1 AND 2. Elimination of Hot Leg Injection Emergency Core Cooling System. (Wisconsin Electric Power Co., Milwaukee). 5 Sep 1972. 2p. (DOCKET-50301–70). Dep. NTIS.

55290 (DOCKET-50266–80) POINT BEACH NUCLEAR PLANT, UNITS 1 AND 2. Valve Wall Thickness. (Directorate of Regulatory Operations (AEC), Glen Ellyn, Ill. Region III). 13 Sep 1972. 7p. (DOCKET-50301–71). Dep. NTIS.

55291 (DOCKET-50272–35) SALEM NUCLEAR GENERATING STATION, UNITS 1 AND 2. Final Safety Analysis Report, Amendment 14. (Public Service Electric and Gas Co., Newark, N. J.). 6 Sep 1972. 415p. (DOCKET-50311–35). Dep. NTIS.

Requested and revised data are presented concerning the quality assurance program; the site; containment systems; engineered safeguards; auxiliary and emergency systems; power conversion system; radioactive waste disposal; radiation protection; and safety analysis. (D.C.C.)

55292 (DOCKET-50277-56) PEACH BOTTOM ATOMIC POWER STATION, UNITS 2 AND 3. Study of Possible Expansion Bellows Failure. (Philadelphia Electric Co., Pa.). 1 Sep 1972. 2p. (DOCKET-50278-56). Dep. NTIS.

55293 (DOCKET-50277-57) PEACH BOTTOM ATOMIC POWER STATION, UNITS 2 AND 3. Final Safety Analysis Report, Amendment 20. (Philadelphia Electric Co., Pa.). 12 Sep 1972. 35p. (DOCKET-50278-57). Dep. NTIS.

Requested and revised data are presented concerning containment atmosphere following loss of coolant accident; radioactive effluents; vibration testing of cooling system components; and emergency core cooling system performance evaluation. (D.C.C.)

55294 (DOCKET-50278-58) PEACH BOTTOM ATOMIC POWER STATION, UNIT 3. Interim Report of Damage to Reactor Pressure Vessel Top Fuel Guide. (Philadelphia Electric Co., Pa.). 16 Aug 1972. 3p. Dep. NTIS.

55295 (DOCKET-50280-82) SURRY POWER STATION, UNIT 1. Technical Specifications, Changes. (Virginia Electric and Power Co., Richmond). 30 Aug 1972. 4p. Dep. NTIS.

Revised technical specifications are presented concerning personnel organization, and site temperature monitoring requirements. (D.C.C.)

55296 (DOCKET-50280-84) SURRY POWER STATION, UNIT 1. Inspection to Examine the Malfunction of the Decay Heat Release System. (Directorate of Regulatory Operations (AEC), Atlanta, Ga. (USA). Region II). 12 Sep 1972. 63p. Dep. NTIS.

55297 (DOCKET-50280-85) SURRY POWER STATION, UNIT 1. Operating Incident of July 27, 1972. (Virginia Electric and Power Co., Richmond). 16 Aug 1972. 32p. Dep. NTIS.

On July 27, 1972, the steam vent system of Surry Power Reactor, Unit 1 malfunctioned resulting in the deaths of two Virginia Electric and Power Company employees. The employees were burned when a sudden opening of the decay heat release valve caused the decay heat release pipe to disengage from the vent sleeve and release steam into the safeguards building. The incident and subsequent events are described in detail. There was no release of radioactivity and the reactor was at all times in a safe condition. (H.D.R.)

55298 (DOCKET-50282-72) PRAIRIE ISLAND NUCLEAR GENERATING PLANT, UNITS 1 AND 2. Valve Wall Thicknesses. (Directorate of Regulatory Operations (AEC), Glen Ellyn, Ill. Region III). 5 Sep 1972. 6p. (DOCKET-50306-69). Dep. NTIS.

55299 (DOCKET-50282-73) PRAIRIE ISLAND NUCLEAR GENERATING PLANT, UNITS 1 AND 2. Final Safety Analysis Report, Amendment 22. (Northern States Power Co., Minneapolis, Minn.). 8 Sep 1972. 438p. (DOCKET-50306-70). Dep. NTIS.

Rinsed and additional data are presented concerning operation aspects, reactor site, cooling system, containment system, engineered safeguards, instrumentation, electrical systems, auxiliary systems, power conversion system, radioactive waste disposal system, testing program, and safety analysis. (D.C.C.)

55300 (DOCKET-50285-70) FORT CALHOUN STATION, UNIT 1. Clarification of Environmental Protection of Containment Prestressing Tendons. (Directorate of Regulatory Operations (AEC), Denver, Colo. Region IV). 11 Jul 1972. 5p. Dep. NTIS.

55301 (DOCKET-50285-71) FORT CALHOUN STATION, UNIT 1. Final Environmental Statement. (Directorate of Licensing (AEC), Washington, D. C.). Aug 1972. 272p. Dep. NTIS.

Information concerning chemical, radioactive, and thermal discharges from the reactor is presented. The effects of reactor operations on the environment are analyzed. Ecological, hydrological, and meteorological data on the reactor site are included. Cost-benefit analysis for reactor operation is presented. (D.C.C.)

55302 (DOCKET-50285-72) FORT CALHOUN STATION, UNIT 1. Report of a Minor Variance from the Final Safety Analysis Report. (Directorate of Regulatory Operations (AEC), Denver, Colo. Region IV). 12 Sep 1972. 4p. Dep. NTIS.

Additional information is presented concerning the specifications of welds in the primary pressure boundary piping. (D.C.C.)

55303 (DOCKET-50289-66) THREE MILE ISLAND NUCLEAR STATION, UNIT 1. Final Safety Analysis Report, Amendment 28. (Metropolitan Edison Co., Reading, Pa.). 31 Aug 1972. 27p. Dep. NTIS.

Requested and revised data are presented concerning site meteorology; engineered safeguards; instrumentation; auxiliary systems; radioactive waste disposal system; personnel; operations; and testing program. (D.C.C.)

55304 (DOCKET-50293-88) PILGRIM NUCLEAR POWER STATION. Evaluation of Facilities and Systems. (Directorate of Licensing (AEC), Washington, D. C.). 1 Sep 1972. 4p. Dep. NTIS.

The possibility of Class 1 equipment being flooded by the failure of the circulating water system or the fire protection system is analyzed. (D.C.C.)

55305 (DOCKET-50293-90) PILGRIM NUCLEAR POWER STATION. Issuance of Facility Operating License DPR-35, Amendment 1. (Directorate of Licensing (AEC), Washington, D. C.). 15 Sep 1972. 257p. Dep. NTIS.

55306 (DOCKET-50295-61) ZION STATION NUCLEAR POWER PLANT, UNITS 1 AND 2. Final Safety Analysis Report, Amendment 22. (Commonwealth Edison Co., Chicago, Ill.). 10 Aug 1972. 454p. (DOCKET-50304-61). Dep. NTIS.

Requested and revised data are presented concerning radioactive effluents; containment system; engineered safeguards; emergency core cooling system; post criticality testing; quality assurance program; personnel organization; operation procedures; safety aspects of aircraft impact; instrumentation; and electrical systems. The emergency plan for the Zion Power Reactor Units 1 and 2 is included. (D.C.C.)

55307 (DOCKET-50298-50) COOPER NUCLEAR STATION. Susceptibility of Engineered Safety Systems to Failure as a Result of Flooding. (Nebraska Public Power District, Columbus). 8 Sep 1972. 3p. Dep. NTIS.

55308 (DOCKET-50302-52) CRYSTAL RIVER NUCLEAR GENERATING PLANT, UNIT 3. Antitrust Review. (Florida Power Corp., St. Petersburg). 1 Sep 1972. 2p. Dep. NTIS.

55309 (DOCKET-50305-48) KEWAUNEE NUCLEAR POWER PLANT. Final Safety Analysis Report, Amendment 21. (Wisconsin Public Service Corp., Green Bay). 31 Aug 1972. 113p. Dep. NTIS.

Revised information is presented concerning containment system; engineered safeguards; instrumentation; protection systems; electrical systems; radioactive waste disposal systems; and safety analysis. (D.C.C.)

55310 (DOCKET-50305-49) KEWAUNEE NUCLEAR POWER PLANT. Valve Wall Thickness. (Directorate of Regulatory Operations (AEC), Glen Ellyn, Ill. Region III). 13 Sep 1972. 8p. Dep. NTIS.

55311 (DOCKET-50305-51) KEWAUNEE NUCLEAR POWER PLANT. Final Safety Analysis Report, Amendment 21, Errata Sheets. (Wisconsin Public Service Corp., Green Bay). 11 Sep 1972. 9p. Dep. NTIS.

55312 (DOCKET-50309-68) MAINE YANKEE ATOMIC POWER STATION. Worst Case LOCA Reanalyzed. (Maine Yankee Atomic Power Co., Westboro, Mass.). 12 Sep 1972. 1p. Dep. NTIS.

55313 (DOCKET-50309-69) MAINE YANKEE ATOMIC POWER STATION. Issuance of Facility Operating License DPR-36. (Directorate of Licensing (AEC), Washington, D. C.). 15 Sep 1972. 190p. Dep. NTIS.

55314 (DOCKET-50312-50) RANCHO SECO NUCLEAR GENERATING STATION, UNIT 1. Steps Taken to Correct the Item Brought to Attention in Letter Dated July 26, 1972. (Directorate of Regulatory Operations (AEC), Berkeley, Calif. (USA). Region V). 8 Sep 1972. 2p. Dep. NTIS.

Requested information is presented concerning quality assurance procedures for the installation of electrical cables. (D.C.C.)

55315 (DOCKET-50312-51) RANCHO SECO NUCLEAR GENERATING STATION, UNIT 1. Final Safety Analysis Report and License Application, Amendment 15. (Sacramento Municipal Utility District, Calif.). 11 Sep 1972. 359p. Dep. NTIS.

Requested and revised data are presented concerning the quality assurance program, cooling system, containment system, engineered safeguards, instrumentation, auxiliary systems, power conversion system, radioactive waste disposal system, testing programs, and safety analysis. Financial data on the owners of the reactor are included. The 1971 Annual Report for the Sacramento Municipal Utility District is presented. (D.C.C.)

55316 (DOCKET-50312-52) RANCHO SECO NUCLEAR GENERATING STATION, UNIT 1. Final Report on Minor Imperfections Found in Pipe Welds. (Sacramento Municipal Utility District, Calif.). 31 Aug 1972. 68p. Dep. NTIS.

55317 (DOCKET-50313–50) ARKANSAS NUCLEAR ONE, UNIT 1. Final Safety Analysis Report, Amendment 29. (Arkansas Power and Light Co., Little Rock). 8 Sep 1972. 165p. Dep. NTIS.

Financial data on the owners of the Arkansas Nuclear One Power Reactor are presented. The 1971 Annual Reports for the Arkansas Power and Light Company and the Middle South Utilities Incorporated are included. Revised data on the reactor are also presented concerning personnel, cooling system, and site meteorology. (D.C.C.)

55318 (DOCKET-50315–74) DONALD C. COOK NUCLEAR PLANT, UNITS 1 AND 2. Safety Evaluation. (Indiana and Michigan Power Co., New York). 14 Jan 1969. 152p. (DOCKET-50316–74). Dep. NTIS.

55319 (DOCKET-50315–75) DONALD C. COOK NUCLEAR PLANT, UNITS 1 AND 2. Valve Wall Thickness. (Directorate of Regulatory Operations (AEC), Glen Ellyn, Ill. Region III). 13 Sep 1972. 9p. (DOCKET-50316–75). Dep. NTIS.

55320 (DOCKET-50315–76) DONALD C. COOK NUCLEAR PLANT, UNITS 1 AND 2. Provisional Construction Permits Nos. CPPR-60 and CPPR-61. (Division of Reactor Licensing (AEC), Washington, D. C.). 25 Mar 1969. 6p. (DOCKET-50316–76). Dep. NTIS.

55321 (DOCKET-50315–77) DONALD C. COOK NUCLEAR PLANT, UNITS 1 AND 2. Tornado and Missile Considerations for the Spent Fuel Pit. (American Electric Power Service Corp., New York). Jun 1969. 60p. (DOCKET-50316–77). Dep. NTIS.

55322 (DOCKET-50315–78) DONALD C. COOK NUCLEAR PLANT, UNITS 1 AND 2. Design Changes. (American Electric Power Service Corp., New York). 10 Jun 1969. 6p. (DOCKET-50316–78). Dep. NTIS.

Design changes are described for the steam generator isolation valve, the emergency core cooling system, and the containment spray system. An increase in the average temperature for the reactor coolant is discussed. (D.C.C.)

55323 (DOCKET-50315–79) DONALD C. COOK NUCLEAR PLANT, UNITS 1 AND 2. Initial Decision. (Atomic Energy Commission, Washington, D. C. Atomic Safety and Licensing Board). 21 Mar 1969. 10p. (DOCKET-50316–79). Dep. NTIS.

Authorization for issuance of provisional construction permits for the Donald C. Cook Power Reactor Units 1 and 2 is presented. (D.C.C.)

55324 (DOCKET-50315–80) DONALD C. COOK NUCLEAR PLANT, UNITS 1 AND 2. Ice Condenser Containment Independent Analysis Program. (Division of Reactor Licensing (AEC), Washington, D. C.). 26 Jan 1972. 4p. (DOCKET-50316–80). Dep. NTIS.

55325 (DOCKET-50315–81) DONALD C. COOK NUCLEAR POWER PLANT, UNITS 1 AND 2. Benton Harbor Power Plant Limnological Studies. Part IX. The Biological Survey of July 10, 1970. (Michigan Univ., Ann Arbor. Great Lakes Research Div.). Mar 1972. 74p. (DOCKET-50316–81). Dep. NTIS.

For American Electric Power Service Corp., New York and Indiana and Michigan Electric Co., New York.

55326 (DOCKET-50315–82) DONALD C. COOK NUCLEAR POWER PLANT, UNITS 1 AND 2. Final Safety Analysis Report, Amendment 28. (American Electric Power Service Corp., New York). 23 Aug 1972. 11p. (DOCKET-50316–82). Dep. NTIS.

The environmental monitoring programs for chemical and thermal discharges from the reactors are described. (D.C.C.)

55327 (DOCKET-50317–58) CALVERT CLIFFS NUCLEAR POWER PLANT, UNITS 1 AND 2. Final Safety Analysis Report, Amendment 25. (Baltimore Gas and Electric Co., Md.). 1 Sep 1972. 57p. (DOCKET-50318–58). Dep. NTIS.

Revised and additional data are presented on the following topics: transmission lines; environmental radiation monitoring program; lightning protection for the containment structure; site emergency plan; and reliability testing of the main steam isolation valve actuation system. (D.C.C.)

55328 (DOCKET-50321–49) EDWIN I. HATCH NUCLEAR PLANT, UNIT 1. Pump and Valve Committee Report, Main Steam Isolation Valves, July 26, 1972. (Directorate of Regulatory Operations (AEC), Atlanta, GA. (USA). Region II). 7 Sep 1972. 156p. Dep. NTIS.

55329 (DOCKET-50324–43) BRUNSWICK STEAM ELECTRIC PLANT, UNITS 1 AND 2. Conclusion That BSEP Does Not Have a Flooding Problem. (Carolina Power and Light Co., Raleigh, N. C.). 1 Sep 1972. 1p. (DOCKET-50325–44). Dep. NTIS.

Due to the plant arrangement of the engineered safeguard equipment it is concluded that a failure of the circulating water system would not result in flooding of the equipment. (D.C.C.)

55330 (DOCKET-50331–52) DUANE ARNOLD ENERGY CENTER. Valve Wall Thicknesses. (Directorate of Regulatory Operations (AEC), Glen Ellyn, Ill. Region III). 5 Sep 1972. 3p. Dep. NTIS.

55331 (DOCKET-50335–33) HUTCHINSON ISLAND PLANT, UNIT 1. Draft Environmental Statement. (Directorate of Licensing (AEC), Washington, D. C.). Sep 1972. 171p. Dep. NTIS.

Information concerning chemical, radioactive, and thermal discharges from the reactor is presented. The effects of reactor operations on the environment are analyzed. Geological, ecological, and meteorological data on the reactor site are included. Cost-benefit analysis for reactor operation is presented. (D.C.C)

55332 (DOCKET-50338–51) NORTH ANNA POWER STATION, UNITS 1, 2, 3, AND 4. Environmental Considerations, Additional Information. (Virginia Electric Power Co., Richmond). 11 Sep 1972. 52p. (DOCKET-50339–48; DOCKET-50404–23; DOCKET-50405–23). Dep. NTIS.

Requested additional information is presented concerning transmission lines. (D.C.C.)

55333 (DOCKET-50341–45) ENRICO FERMI ATOMIC POWER PLANT, UNIT 2. Valve Wall Thicknesses. (Directorate of Regulatory Operations (AEC), Glen Ellyn, Ill. Region III). 13 Sep 1972. 7p. Dep. NTIS.

55334 (DOCKET-50344–31) TROJAN NUCLEAR PLANT. Inspection of August 7–11, 1972. (Directorate of Regulatory Operations (AEC), Berkeley, Calif. (USA). Region V). 7 Sep 1972. 4p. Dep. NTIS.

55335 (DOCKET-50352–28) LIMERICK GENERATING STATION, UNITS 1 AND 2. Applicant's Environmental Report, Construction Permit Stage (Revised), Supplement 2. (Philadelphia Electric Co., Pa.). 18 Sep 1972. 19p. (DOCKET-50353–28). Dep. NTIS.

55336 (DOCKET-50354–28) NEWBOLD ISLAND NUCLEAR GENERATING STATION, UNITS 1 AND 2. Population Estimates and Projections for Newbold Island Region. (Public Service Electric and Gas Co., Newark, N. J.). 18 Aug 1972. 165p. (DOCKET-50355–27). Dep. NTIS.

55337 (DOCKET-50358–41) WILLIAM H. ZIMMER NUCLEAR POWER STATION, UNIT 1. Final Environmental Statement. (Directorate of Licensing (AEC), Washington, D. C.). 9 Sep 1972. 196p. Dep. NTIS.

Information concerning chemical, radioactive, and thermal discharges from the reactor is presented. The effects of reactor operations on the environment are analyzed. Ecological, geological, hydrological, and meteorological data on the reactor site are included. Cost-benefit analysis for reactor operations is presented. (D.C.C.)

55338 (DOCKET-50361–27) SAN ONOFRE NUCLEAR GENERATING STATION, UNITS 2 AND 3. Environmental Report, Amendment 1, Supplement. (Southern California Edison Co., Rosemead, Calif.). 5 Sep 1972. 503p. (DOCKET-50362–26). Dep. NTIS.

Information concerning radioactive and thermal discharges from the reactors is presented. The effects of reactor operations on the environment are analyzed. Site meteorology and radiation monitoring program are discussed. Requested data on cost-benefit analysis for reactor operations are included. (D.C.C.)

55339 (DOCKET-50363–37) FORKED RIVER NUCLEAR GENERATING STATION, UNIT 1. Preliminary Safety Analysis Report, Amendment 22. (Jersey Central Power and Light Co., Morristown, N. J.). 8 Sep 1972. 64p. Dep. NTIS.

The preliminary safety analysis report for the Forked River Nuclear Generating Station, Unit 1 is amended by the submission of revised figures. (H.D.R.)

55340 (DOCKET-50367–31) BAILLY GENERATING STATION, NUCLEAR I. Valve Wall Thicknesses. (Directorate of Regulatory Operations (AEC), Glen Ellyn, Ill. Region III). 5 Sep 1972. 2p. Dep. NTIS.

55341 (DOCKET-50373–27) LA SALLE COUNTY STATION, UNITS 1 AND 2. Valve Wall Thicknesses. (Directorate of Regulatory Operations (AEC), Glen Ellyn, Ill. Region III). 5 Sep 1972. 3p. (DOCKET-50374–26). Dep. NTIS.

55342 (DOCKET-50390–23) WATTS BAR NUCLEAR PLANT, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amend-

ment 15. (Tennessee Valley Authority, Chattanooga). 22 Aug 1972. 47p. (DOCKET-50391-23). Dep. NTIS.

The preliminary safety analysis report for the Watts Bar Power Reactor, Units 1 and 2 is amended by the submission of revised and additional information. (H.D.R.)

55343 (DOCKET-50390-24) WATTS BAR NUCLEAR PLANT, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment 16. (Tennessee Valley Authority, Chattanooga). 12 Sep 1972. 7p. (DOCKET-50391-24). Dep. NTIS.

The preliminary safety analysis report for the Watts Bar Power Reactor, Units 1 and 2 is amended by the submission of revised information. (H.D.R.)

55344 (DOCKET-50395-28) VIRGIL C. SUMMER NUCLEAR STATION, UNIT 1. Preliminary Safety Analysis Report, Amendment 16. (South Carolina Electric and Gas Co., Columbia). 12 Sep 1972. 223p. Dep. NTIS.

Revised and additional data are presented concerning reactor site, structures, engineered safeguards, containment system, auxiliary systems, power conversion system, and instrumentation. (D.C.C.)

55345 (DOCKET-50397-28) HANFORD NO. 2 NUCLEAR POWER PLANT. Preliminary Safety Analysis Report, Amendment 12. (Washington Public Power Supply System, Richland). 31 Aug 1972. 103p. Dep. NTIS.

Requested and revised data are presented concerning the site; cooling system; containment system; electrical system; auxiliary systems; and structures. (D.C.C.)

55346 (DOCKET-50397-32) HANFORD NO. 2 NUCLEAR POWER PLANT. Preliminary Safety Analysis Report, Amendment 12. (Washington Public Power Supply System, Richland). 31 Aug 1972. 103p. Dep. NTIS.

Requested and revised data are presented concerning auxiliary systems, reactor site, cooling system, containment system, electrical systems, power conversion system, and mechanical structures. (D.C.C.)

55347 (DOCKET-50398-18) MENDOCINO POWER PLANT, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment 11. (Pacific Gas and Electric Co., San Francisco, Calif.). 1 Sep 1972. 137p. (DOCKET-50399-18). Dep. NTIS.

Requested and revised information is presented concerning the containment system; radioactive waste disposal; fire protection system; auxiliary systems; Class 1 structures; engineered safeguards; instrumentation; valves; support structures; piping systems; pumps; and power conversion system. (D.C.C.)

55348 (DOCKET-50398-19) MENDOCINO POWER PLANT, UNITS 1 AND 2. Environmental Report, Supplement, Volume 3. (Pacific Gas and Electric Co., San Francisco, Calif.). 11 Sep 1972. 347p. (DOCKET-50399-19). Dep. NTIS.

The environmental aspects of transmission line construction are described for the Mendocino Power Reactor, Units 1 and 2. (H.D.R.)

55349 (DOCKET-50404-22) NORTH ANNA POWER STATION, UNITS 3 AND 4. Preliminary Safety Analysis Report, Amendment 8. (Virginia Electric and Power Co., Richmond). 2 Sep 1972. 55p. (DOCKET-50405-22). Dep. NTIS.

Revised and additional data are presented on the following topics: earthquake stress limits for Class 1 equipment; mechanical properties of stainless steel pipes; quality assurance program; accident analysis; service water reservoir; and containment depressurization system. (D.C.C.)

55350 (DOCKET-50409-13) LA CROSSE BOILING WATER REACTOR. Valve Wall Thickness. (Directorate of Regulatory Operations (AEC), Glen Ellyn, Ill. Region III). 13 Sep 1972. 7p. Dep. NTIS.

55351 (DOCKET-50410-10) NINE MILE POINT NUCLEAR STATION, UNIT 2. Environmental Report, Supplement 1. (Niagara Mohawk Power Corp., Syracuse, N. Y.). 28 Aug 1972. 128p. Dep. NTIS.

Additional information is presented concerning alternate sites and power transmission lines. (D.C.C.)

55352 (INIS-mf-205) FORSMARK'S NUCLEAR POWER STATION. The Distribution of Cooling Water in Oeregrundsgrepen. Report on Experiments with Models, April-June 1971. (Swedish State Power Board, Alvkarleby. Hydraulic Lab.). Jul 1971. 198p. (In Swedish). INIS.

Model experiments are described for finding the most suitable performance and location of the paths of cooling water at the planned nuclear power station at Forsmark in Sweden. The purpose was to obtain a solution which permitted building of an extensible plant with the smallest possible temperature increase in the surroundings. Fifty-five experiments were performed in scale 1:350 (horizontal) and 1:50 (vertical). (INIS)

55353 (NEDO-10527) ROD DROP ACCIDENT ANALYSIS FOR LARGE BOILING WATER REACTORS. Paone, C. J.; Stirn, R. C.; Woolley, J. A. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Mar 1972. 74p. (72-NED-18).

The analysis of super-prompt critical nuclear excursions in large water-moderated reactors is described. The technical analysis tools used in studying hypothetical nuclear transients are described herein, without considering the probability of such an occurrence. The rod drop accident has been reanalyzed generically using the improved methods, and the results of these analyses are presented. In addition, detailed sensitivity studies have been performed to evaluate the effects of initial reactor conditions, control rod worth, rod drop velocity, and scram insertion rate on the resultant peak fuel enthalpy. 38 references. (auth)

55354 RADIOPROTECTION DURING THE INTERVENTIONS AT SAINT-LAURENT-DES-EAUX. Grand, J.; Hurtiger, J. (Electricite de France, Saint-Laurent-des-Eaux). Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.): No. 91, 38-53(Sep 1971). (In French).

The careful preparation of interventions and the development of an efficient radioprotection system enabled repairs to be successfully carried out on the Saint-Laurent-des-Eaux 1 reactor after the accident of 17 October 1969, without injury to the participating personnel. The work involved the localization of U debris, its recovery, and the trapping of inaccessible pieces. The operation was accomplished by establishing two large work yards in which the work was carried out over a period of several months: one on the upper plug of the reactor, and the other inside the reactor vessel. The measures taken to adapt the workers to the radioactive environment (the training of the workers, and their special equipment) are discussed. The toxicity and contamination risks run by the personnel involved in the intervention are considered. (France)

55355 U.S. REACTOR LICENSING RECENT DEVELOPMENTS. Nucl. Eng. Int.; 17: No. 193, 468-71(Jun 1972).

Legislative changes and proposals resulting from the growing opposition to nuclear energy on environmental grounds are described. These include suitable amendments to the Atomic Energy Act concerning interim licensing for plant operation; major changes in structure of AEC regulating functions and staff; new guidelines for release of radioactivity; and a program for improvement of water quality. The effect of NEPA, the National Environmental Policy Act of 1969, is discussed and future changes including proposed alterations for safety and reliability reports are considered. (UK)

Propulsion and Auxiliary Power Reactors

Refer also to abstracts 53093, 53094, 53233, 54921, 54945-54950, 54954, and 54962.

55356 (CONF-720901-(Bks.1 and 2), pp 471-9) CNSG: NUCLEAR SHIP OXYGEN ACTIVATION CALCULATIONAL METHOD WITH EXPERIMENTAL COMPARISON. Anderson, F. N. (Babcock and Wilcox, Lynchburg, Va.). 1972.

From Meeting on new developments in reactor physics and shielding calculations; Kiamesha Lake, NY. (12 Sep 1972).

The Consolidated Nuclear Steam Generator (CNSG) reactor is being considered for maritime application. In this design the compactness of the reactor system permits the steam generator to be located inside the pressure vessel. Consequently, the secondary coolant is exposed to a high-energy neutron flux field which activates the oxygen. This creates a radiation exposure hazard to personnel since the transit time of the activated secondary coolant outside the biological shield is small relative to the half-life of the activated oxygen. A method is outlined for calculating the oxygen activation and the dose rate associated with the decay gamma rays. This method was used to analyze the oxygen activation in the German Nuclear ship OTTO HAHN, which utilizes an earlier version of the CNSG design. Calculated and estimated dose rates are 0.003 and 0.01 mR/h, respectively. 15 references. (auth)

55357 (DOCKET-50238-92) N. S. SAVANNAH. Action Taken with Respect to Noncompliance Items of March 1972 Inspection. (Directorate of Regulatory Operations (AEC), Washington, D. C.). 1 Sep 1972. 3p. Dep. NTIS.

55358 (N–72–18051) BLEED-CYCLE PROPELLANT PUMPING IN A GAS-CORE NUCLEAR ROCKET ENGINE SYSTEM. Kascak, Albert F.; Easley, Annie J. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Mar 1972. 76p. (NASA-TM-X–2517; E–6639). NTIS.

The performance of ideal and real staged primary propellant pumps and bleed-powered turbines was calculated for gas-core nuclear rocket engines over a range of operating pressures from 500 to 5000 atm. This study showed that for a required engine operating pressure of 1000 atm the pump work was about 0.8 hp/(lb/sec), the specific impulse penalty resulting from the turbine propellant bleed flow as about 10 percent; and the heat required to preheat the propellant was about 7.8 MN/(lb/sec). For a specific impulse above 2400 sec, there is an excess of energy available in the moderator due to the gamma and neutron heating that occurs there. Possible alternative pumping cycles are the Rankine or Brayton cycles. (auth) (STAR)

55359 (NASA-TM-X–2440, pp 2-12) SPACE NUCLEAR PROPULSION SYSTEMS AND APPLICATIONS. Schwenk, Francis C. (Space Nuclear Systems Office, Washington, D. C.). Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

The basic principles of the operation of a nuclear rocket engine are reviewed along with a summary of the early history. In addition, the technology status in the nuclear rocket program for development of the flight-rated NERVA engine is described, and applications for this 75,000-pound-thrust engine and the results of nuclear stage studies are presented. Advanced research and supporting technology activities in the nuclear rocket program are also summarized. (auth)

55360 (NASA-TM-X–2440, pp 84-91) SNAP-8 POST-SHUTDOWN GAMMA-RADIATION APPROXIMATIONS. Byrn, N. R. (Teledyne Brown Eng., Huntsville, Ala); Smith, H. T.; Manning, H. S. Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

An evaluation was made of an approximate method for calculating the dose rate resulting from fission product gamma radiation after reactor shutdown. Safety analyses for advanced nuclear missions in space have used this technique for determining radiologically safe operations. This method assumes that the dose rate, $D_1(r,t)$, received from a shutdown reactor is directly proportional to the residual gamma power level at that time. To check the validity of this "power ratio" assumption, energy-dependent detector responses were calculated for normalized sources in the Perkins and King energy group structure for a SNAP 8 power system on a NASA space station. Gamma decay rates were then calculated by using an expanded, updated list of isotopic decay data, and from these, actual detector responses $D_2(r,t)$ were found for the SNAP 8 system. The two detector responses, D_1 and D_2, were then compared at several times after shutdown and at detector positions around the space station. An error of several thousand percent was found for many detectors at times greater than one year; it was also found that an increase in material attenuation produced an increase in error and that energy-dependent detector response, such as dose rates, showed greater discrepancy between D_1 and D_2 than did the energy flux. It was concluded that these discrepancies were caused by a decrease in the proportion of high-energy gammas released at longer shutdown times. This softening of the decay gamma spectrum with time caused an increased attenuation of decay gamma energy; invalidating the power ratio assumption. Because of the complexity of the space station geometry, these conclusions were checked and verified by a point source in infinite water calculation. The results indicate that energy-dependent calculations must be made to determine decay gamma dose rates for actual reactor configurations. A simplified method for making these calculations has been devised. (auth)

55361 (NASA-TM-X–2440, pp 257-63) RADIATION ENVIRONMENT FOR RENDEZVOUS AND DOCKING WITH NUCLEAR ROCKETS. Rogers, D. R.; Warman, E. A.; Lindsey, B. A. (Aerojet Nuclear Systems Co., Sacramento, Calif.). Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

Planning for operations such as rendezvous and docking of a vehicle powered by a nuclear rocket engine with a space station requires consideration of the radiation environment produced by the engine in addition to the natural space radiation environment. Radiation environment data for the NERVA engine are provided which may be utilized in estimating radiation exposures associated with various space maneuvers. Spatial distributions of neutron and gamma tissue kerma rates produced during full thrust operation of the engine are presented. The corresponding biological dose rates will be due predominantly to neutron contributions except within the region in space which is shadowed by the liquid hydrogen propellant. Forward of the vehicle, dose rates will depend on the characteristics of the propellant module and payload as well as those of the engine and will vary during a mission as propellant is consumed. Final rendezvous with an orbiting space station would be achieved subsequent to full thrust operation during a period of 10 or more hours duration in which impulse is delivered by the propellant used for removal of decay heat. Consequently, post operation radiation levels are of prime importance in estimating space station exposures. Maps of gamma kerma rates around the engine are provided for decay times of 4 and 24 hours after a representative firing. Typical decay curves illustrating the dependence of post operation kerma rates on decay time and operating history are included. Examples of the kerma distributions around the engine which result from integration over specific exposure periods are shown. (auth)

55362 (NASA-TM-X–2440, pp 264-9) RADIATION EXPOSURE TO THE ORBITING LUNAR STATION AND LUNAR SURFACE RELATED TO REUSABLE NUCLEAR SHUTTLE OPERATIONS. Hutchinson, Paul I. (Lockheed Missiles and Space Co., Sunnyvale, Calif.). Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

The radiation environment created by the Reusable Nuclear Vehicle (RNS) in performing its normal mission functions while in the lunar vicinity and the impact of that environment on the Orbiting Lunar Station (OLS) and/or the lunar surface are examined. Trajectory data, representative of nominal lunar arrival and departure maneuvers, reflecting the unique operating characteristics of the nuclear engine, provide the basic geometry model for the evaluation of the radiation exposures. Other factors included in the evaluation are the operating source term (neutron and gamma radiation), shutdown source term (fission point gamma radiation), view angle (shielding effects of stage and engine hardware), separation distance, exposure interval, time after shutdown, and prior reactor operating history. To permit recovery of the impulse available from the coolant flow required by the high decay heat rates at reactor shutdown, the main engine LOI burn is terminated with the RNS in elliptical orbit and the coolant impulse used to circularize the orbit and complete OLS rendezvous. This circularization maneuver may take up to 40 hours or more, depending on the percent of cooldown impulse recovery planned. Radiation exposures at the OLS were evaluated for two conditions: (1) final orbit insertion 10 km ahead of the OLS, and (2) 10 km behind the OLS assuming a 90-percent cooldown impulse recovery about 12 hours of cooling. Radiation exposures to the OLS during the lunar orbit departure burn (TEI) were evaluated for RNS startup 10 km behind the OLS and 10 km and 20 nm ahead of the OLS. Exposures received at the OLS for these cases are higher than for the LOI burn, since the reactor operation occurs much closer to the OLS, indicating greater initial separations will normally be desirable. Lunar surface exposures from the operating reactor were evaluated for both the arrival and departure burns and while there is little probability that manned bases would lie along the paths in which measurable exposures would be recorded, the analyses do indicate the need to consider this possibility in planning such operations. Conclusions supported by the analyses and recommended operational constraints for the RNS are presented. (auth)

55363 (NASA-TM-X–2440, pp 270-6) INTEGRAL DOSE DURING CONSTANT-VELOCITY MOTION NEAR A SPACE POWER REACTOR. Manning, H. S. (Marshall Space Flight Center, Huntsville, Ala.). Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

The dose rate in a rotationally-symmetric radiation field near a space power reactor is assumed to be inversely proportional to separation distance squared and directly proportional either to a constant or a constant times the sine-cubed of a polar angle. Constant velocity motion (constant speed and direction) is examined in both cases in both two- and three-dimensional geometries. The two-dimensional geometry occurs when the line of motion and the field axis of symmetry are co-planar. The dose integral in the sine-cubed region may be integrated directly, but a more useful form is obtained after a change of variable. A coordinate system rotation greatly simplifies the results. The three-dimensional problem is integrated after a change of variable. Finally, tables of normalized functions are presented and discussed. (auth)

55364 (NASA-TM-X–2440, pp 292-8) NUCLEAR RADIATION PROBLEMS, UNMANNED THERMIONIC REACTOR ION PROPULSION SPACECRAFT. Mondt, J. F.; Sawyer, C. D.; Nakashima, A. (California Inst. of Tech., Pasadena). Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

A nuclear thermionic reactor as the electric power source for an electric propulsion spacecraft introduces a nuclear radiation environment. The radiation environment affects the spacecraft configuration, the use and location of electrical insulators and the science experiments. The spacecraft is conceptually configured to minimize the nuclear shield weight by (1) a large length to diameter spacecraft, (2) eliminating piping penetrations through the shield, and (3) using the mercury propellant as gamma shield. The alumina material is damaged by the high nuclear radiation environment in the reactor. For the more ambitious (250 kW(e) 30 to 40,000 hour) electric propulsion missions it is desirable to locate the alumina insulator outside the reflector or develop a more radiation resistant insulator. The net spacecraft nuclear environment is being investigated to determine if there is a problem. It appears some experiments may require local radiation shielding. (auth)

55365 (NASA-TM-X-2440, pp 299-306) THERMIONIC REACTOR POWER SYSTEM: EFFECTS OF RADIATION ON INTEGRATION WITH MANNED SPACE STATION. Gietzen, A. J.; Heath, C. A.; Perry, L. W. (Gulf General Atomic Co., San Diego, Calif.). Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

The application of a thermionic reactor power system to the modular space station is described. The nominal net power is 40 kW(e), with the power system designed to be applicable over the power range from 25 to 60 kW(e). The power system is designed to be launched by the space shuttle. The lifetime goal is 5 years. Radiation protection is provided by LiH neutron shielding and W gamma shielding in a shaped 4π configuration, i.e., the reactor is shielded on all sides but not to equal extent. Isodose contours are presented for the region around the modular space station. Levels and spectral distribution of radiation are given for later evaluation of effects on space station experiments. Parametric data on the effects of separation distance on power system mass are presented. An alternate concept in which a reactor system is connected to the Space Station by a tether at a distance of 1 to 2.5 miles is discussed. The effect upon power system performance and shielding requirements of the tethered concept are presented. (auth)

55366 (NASA-TM-X-2440, pp 392-6) CARPET PLOT DATA FORMAT. O'Byrne, Joseph M. (Univ. of Massachusetts, Amherst). Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

Analysis and interpretation of data is the crucial phase of the decision making process. The interplay between variables must be considered as to their relative significance upon the final result, and sometimes time-sensitive decisions must be made when actual events deviate from predicted information, such as Apollo 13. As the number of variables increases past say four, the traditional method of cross-plotting tends to break down, and digital/analog results cannot present a sharply defined method of analysis. A graphical system named "carpet plot," (since it covers anything), is suggested in which an unlimited number of complicated relationships of variables can be evaluated. (auth)

55367 (NASA-TM-X-2440, pp 440-8) EXTERNAL GAMMA RADIATION ENVIRONMENT FROM THE KIWI, PHOEBUS, AND PEWEE REACTORS. Malenfant, Richard E. (Los Alamos Scientific Lab., N. Mex.). Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

Ground tests of high-powered propulsion-prototype reactors have provided several opportunities to observe the external radiation environment. Although the data may not be directly applicable to the evaluation of radiation levels for flight systems, they do provide an extensive set of results for comparison with calculations on systems similar to those which may be flown. In addition, the experience with reactor radiation fields covering square miles is considered unique. Reactor tests have been conducted in free air (the Kiwi B4D and B4E reactors) and inside of open well shields (the Phoebus 1-B, Phoebus 2-A, and Pewee 1 reactors). Measurements were taken over distances ranging from contact with the pressure vessel out to greater than 5000 feet both during operation and after shutdown. Separate assessments of the effects of direct beam, scatter, capture, and activation were attempted. Some measurements characteristic of each of the systems named will be presented and compared with results of calculations. (auth)

55368 (NASA-TM-X-2440, pp 449-59) APPLICATION OF TRANSPORT TECHNIQUES TO THE ANALYSIS OF NERVA SHADOW SHIELDS. Capo, M. A.; Anderson, S. L. (Westinghouse Electric Corp., Large, Pa.). Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

To design a minimum weight shield internal to the NERVA Nuclear Subsystem, the capabilities and limitations of the analytical techniques must be clearly understood. To further this understanding, an in-depth study was performed in which both one and two dimensional discrete ordinate techniques were applied to the analysis of several shadow shield experiments. These experiments were performed on the PAX reactor which was modified to simulate the R-1 reactor, an upgraded version of the NRX nuclear rocket technology series of reactors tested at Nevada during the past six years. Two significantly different shield mockups were analyzed. In one experiment, the internal shield material called BATH (a composite mixture of boron carbide, aluminum and titanium hydride) was mocked up by alternating thin sheets of titanium, Boral, aluminum and polyethylene. In another experiment a borated steel-liquid hydrogen shield was mocked up by alternating layers of borated steel and polyethylene. The two-dimensional discrete ordinates code, DOT-11W, was employed to calculate 16 group (11 fast and 5 thermal) neutron fluxes internal to the shield mockups. These fluxes were processed by the NAGS code to obtain photon sources throughout the assembly. Photon flux distributions were obtained by employing these sources in fixed source, thirteen group, DOT calculations. An S_8 angular quadrature was employed. Approximately 8000 mesh cells were utilized to describe the two-dimensional geometry. One-dimensional analysis was accomplished by means of the ANISN code. Briefly, this technique employed 29 (16 neutron and 13 photon) energy groups simultaneously in one problem with the photon source generation process treated as a downscattering interaction from one of the neutron groups to one of the photon groups. Two approximations to account for transverse leakage were investigated: (1) the addition of a DB^2 correction to the energy-dependent absorption cross section, and, (2) a "void" streaming correction for geometrical regions containing no material. (auth)

55369 (NASA-TM-X-2440, pp 460-5) RADIATION HEATING IN SELECTED NERVA ENGINE COMPONENTS. Courtney, J. C.; Hertelendy, N. A.; Lindsey, B. A. (Aerojet Nuclear Systems Co., Sacramento, Calif.). Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

The role of heating from nuclear radiation in design of the NERVA engine is treated. Generally, radiation heating is more restrictive in design than material degradation considerations. Some components are subjected to very high gamma heating rates in excess of 0.5 Btu/in^3-sec in steel in the primary nozzle or 0.25 Btu/in^3-sec in aluminum in the pressure vessel. These components must be cooled by a fraction of the liquid hydrogen propellant before it is passed through the core, heated, and expanded out the nozzle as a gas. Other components that are subjected to lower heating rates such as the thrust structure and the disk shield are designed so that they would not require liquid hydrogen cooling. Typical gamma and neutron heating rates, resulting temperatures, and their design consequences are covered. The calculational techniques used in the nuclear and thermal analyses of the NERVA engine are briefly treated. (auth)

55370 (NASA-TM-X-2440, pp 471-5) RADIATION HARDENING OF COMPONENTS AND SYSTEMS FOR NUCLEAR ROCKET VEHICLE APPLICATIONS. Greenhow, William A.; Cheever, Paul R. (Convair Aerospace Div., Fort Worth, Tex.). Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

The results of the analysis of the S-II and S-IVB components, although incomplete, indicate that many Saturn V components and subsystems, e.g., pumps, valves, etc., can be radiation hardened to meet nuclear rocket vehicle (NRV) requirements by material substitution and minor design modifications. Results of these analyses include: (1) recommended radiation tolerance limits for over 100 material applications, (2) design data which describes the components of each system which can be employed on the NRV and the modifications necessary to radiation harden other components, (3) presentation of radiation hardening examples of systems which will provide guidance to component designers, and (4) designing radiation effects tests to supply data for selecting materials with confidence. (auth)

55371 (NASA-TM-X-2440, pp 681-6) DISCRETE ORDINATES-MONTE CARLO COUPLING: A COMPARISON OF TECHNIQUES IN NERVA RADIATION ANALYSIS. Lindstrom, D. G.; Normand, E.; Wilcox, A. D. (Aerojet Nuclear Systems Co., Sacramento, Calif.). Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

In the radiation analysis of the NERVA Nuclear Rocket System,

two-dimensional discrete ordinates calculations are sufficient to provide detail in the pressure vessel and reactor assembly. Other parts of the system, however, require three-dimensional Monte Carlo analyses. To use these two methods in a single analysis, a means of coupling was developed whereby the results of a discrete ordinates calculation can be used to produce source data for a Monte Carlo calculation. Several techniques for producing source detail were investigated. Results of calculations on the NERVA system are compared and limitations and advantages of the coupling techniques discussed. (auth)

55372 (NASA-TM-X-2440, pp 692-6) APPLICATION OF MORSE TO RADIATION ANALYSIS OF NUCLEAR FLIGHT PROPULSION MODULES. Woolson, W. A. (Aerojet Nuclear Systems Co., Sacramento, Calif.). Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

Several modifications and additions were made to the multigroup Monte Carlo code MORSE to implement its use in a computational procedure for performing radiation analyses of NERVA Nuclear Flight Propulsion Modules. These changes include the incorporation of a new general geometry module; the inclusion of an expectation tracklength estimator; and the option to obtain source information from two dimensional Discrete Ordinates calculations. Computations comparing MORSE and a point cross section Monte Carlo code, COHORT, were made in which a coupled Discrete Ordinates/Monte Carlo procedure was used to calculate the gamma dose rate at tank top locations of a typical propulsion module. The dose rates obtained from the MORSE computation agreed with the dose rates obtained from the COHORT computation to within the limits of the statistical accuracy of the calculations. (auth)

55373 (NASA-TM-X-2440, pp 1016-20) VENTING OF FISSION PRODUCTS AND SHIELDING IN THERMIONIC NUCLEAR REACTOR SYSTEMS. Salmi, E. W. (Los Alamos Scientific Lab., N. Mex.). Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

Most thermionic reactors are designed to allow the fission gases to escape out of the emitter. There exist several design variations to allow the gas to escape from the reactor core. The final disposition of the gas has several interesting problems. If the gas is put into a chamber, its volume is too large to be contained in the shield. Fortunately the fission gases do not pose a radiation problem at 100 ft. Because of the long half-life the fission gases could prevent any close approach to the reactor after it has been shut down. The fission gases could instead be stored in an absorption trap. An absorption trap is usually assumed to require very low temperatures, however, experimental data indicate that reservoirs at several hundred degrees C can be useful. Another scheme is to simply allow the fission gases to escape. Again, because of the low activity of the fission products, this method should pose no radiation hazards. (auth)

55374 (PREAS-4041-R-4) FRONT ISLAND SHIELD THERMAL DISPLACEMENTS. Tajirian, G. (Allstates Design and Development Co., Inc., Trenton, N. J. (USA)). 16 Mar 1961. Contract AT(11-1)-171. 51p. Dep. NTIS.

For General Electric Co., Cincinnati, Ohio. Aircraft Nuclear Propulsion Dept.

Process Heat and Desalination Reactors

55375 (INIS-mf-172) METROPOLITAN SITING OF NUCLEAR HEATING PLANTS. Beranek, J. (Ceskoslovenska Komise pro Atomovou Energii, Prague). 1970. (CONF-690565-1). INIS.

From Nuclear heating symposium; Tatranska Lomnica, Czechoslovakia (13 May 1969).

Acceptable hazards are discussed to individuals and population around nuclear heating plants constructed inside urban areas, arising from fission products released into the environment during normal operation or in the event of accident. The maximum permissible doses to the thyroid and to the whole body are in Czechoslovakia set at 100 Rems and 25 Rads, respectively. A new limiting factor is discussed concerning the population living in the neighborhood of the projected heating plants in Prague and in Brno—the integral population dose. The question of technical safeguards is dealt with in detail. A combination of all possible types of technical safeguards is required to prevent or minimize damage to safety barriers (emergency cooling system) and to prevent or minimize the release of fission products (various types of containment, containment spray system, filtering system, stack height). Examples of safeguard systems are discussed in relation to the requirements for safety of nuclear power or heating plants sited within conurbations. (INIS)

55376 (INIS-mf-172, pp 7-13) DISTRICT HEATING IN CZECHOSLOVAKIA AND POSSIBILITY OF USING NUCLEAR POWER REACTORS FOR THIS PURPOSE. Vlach, J. (Vyzkumny Ustav Energeticky, Prague (Czechoslovakia)). 1970. (CONF-690565-8). INIS.

From Nuclear heating symposium; Tatranska Lomnica; Czechoslovakia (13 May 1969).

The problems of centralized and decentralized heating in Czechoslovakia are briefly outlined and considerations are presented leading to the orientation to nuclear heating and power plants. To calculate the full heat supply, the overall heat output is divided in nuclear base load and peak load parts. Peak load plants use fossil fuels and also serve as a stand-by. The ratio of nuclear heat to the total output, in addition to fuel prices, depends mainly on duration of the peak load heat demand τ and on the type of the turbine used. For $\tau \geq 5{,}000$ hrs/yr, back-pressure turbines are suitable; smaller τ require condensing bleeder turbines. A distribution of the load among several nuclear reactors may be considered for large plants with high τ. This makes it possible to site nuclear heating and power plants at shorter distances from each other and thus to reduce the cost of the heat distribution system. Further development depends heavily on the cost of nuclear equipment. (INIS)

55377 PROCESS HEAT FROM HIGH TEMPERATURE REACTORS. Bode, K. H.; Schloesser, J. BCC-Nach.; 53: No. 9-10, 259-66(1971). (In German).

A review on the energy market in the Federal Republic of Germany and its estimated further development is followed by a description of various processes for the conversion of fossil raw materials by means of heat from high temperature reactors and the subsequent utilization of these conversion products in some branches of the basic industry. Outlines are given of special reactor engineering problems that have to be solved as they are vital for the utilization of nuclear process heat. (INIS)

Research and Test Reactors

Refer also to abstracts 53224, 55116—55118, 55134, 55144, and 55437.

55378 (AI-AEC-12951) VIM-1: A NON-MULTIGROUP MONTE CARLO CODE FOR ANALYSIS OF FAST CRITICAL ASSEMBLIES. Levitt, L. B.; Lewis, R. C. (Atomics International, Canoga Park, Calif.). 15 May 1970. Contract AT(04-3)-701. 90p. Dep. NTIS.

VIM-1 is the first of a series of Monte Carlo codes designed for analysis of fast critical experiments and fast reactor design. It has been expressly prepared for the analysis of fast critical assemblies of the plate-drawer type. It is written in Fortran, for use on either CDC or IBM computers of the 6600 or 360-75 and up class. Special versions for handling bare and reflected spheres and reflected cylinders are also available, primarily for performing comparisons of heterogeneous and homogeneous calculations. The library uses point cross-section data, rather than multi-group constants. Angular data is in the form of cumulative distribution functions, at energies tailored to the needs of each isotope. Computation times range from three minutes to one hour on the CDC 6600 (depending on the size and spectrum of the assembly) to obtain probable statistical errors in the eigenvalue of less than 0.5%, thus providing a powerful tool for reactor design and experimental analysis at a reasonable cost. 6 references. (auth)

55379 (ANCR-1085) ETR POWER: VARIATION ANALYSIS. Burdick, E. E.; Liebenthal, J. L. (Aerojet Nuclear Co., Idaho Falls, Idaho). Aug 1972. Contract AT(10-1)-1375. 62p. Dep. NTIS.

Between June and December 1971, small (nominally ±0.5% amplitude), intermittent power variations of unknown origin were witnessed at the Engineering Test Reactor. The results of the investigative program carried out to determine the cause of the variations are reported. Included in the report are diagnostics, inspections, and analyses. 11 references. (auth)

55380 (CEA-N-1211) T424 FACILITY FOR DISPLACING FUEL UNDER IRRADIATION. Descamps, Jean-Marie (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Jul 1972. 18p. (In French). Dep. NTIS (U. S. Sales Only).

The T424 facility was designed for experimental fuel irradiations in swimming-pool reactors. The amount of nuclear power released in the fuel is either manually controlled or servo-controlled by an experimental parameter. OSIRIS currently uses three facilities of this nature. (auth)

55381 (CONF-710959–, Paper 6) SODIUM INPILE LOOP. Inagaki, H. 5p.

From Meeting on fission and corrosion product behaviour in primary systems of LMFBR's; Bensberg, Germany (20 Sep 1971).

An inpile liquid sodium loop, for use in the JPR-2 Reactor at JAERI, is described. Results of inpile and out-of-pile performance testing are summarized. (J.M.J.)

55382 (CONF-720901–(Bks.1 and 2), pp 431-41) FFTF PIPE CHASE STREAMING EXPERIMENT. McGregor, B. J.; Muckenthaler, F. J. (Oak Ridge National Lab., Tenn.). 1972.

From Meeting on new developments in reactor physics and shielding calculations; Kiamesha Lake, NY. (12 Sep 1972).

The FFTF reactor design includes sodium inlet and outlet pipes which penetrate the 4-ft-thick reactor cavity wall at a height of approximately 19 ft above the top of the core. Most neutrons enter these pipe chases at a slant angle and streaming subsequent to scattering in the chase contributes an important source of neutrons to the heat exchanger vaults. Streaming of neutrons can take place along the sodium in the pipes as well as along the clearance gaps and along the low-density insulation surrounding the pipes. Experiments were designed to validate analytical methods which will be used to predict the flux levels in the heat exchanger vault and piping. The experimental calculation reported was a steel-lined concrete pipe chase and sodium-filled pipe mockup placed in a collimated neutron beam at an angle of 60 deg. (auth)

55383 (CONF-720901–(Bks.1 and 2), pp 445-58) STATUS OF THE FTR SHIELDING DESIGN ANALYSIS AND METHODS. Rathbun, J. L.; Fox, P. F. (Westinghouse Electric Corp., Madison, Pa.). 1972.

From Meeting on new developments in reactor physics and shielding calculations; Kiamesha Lake, NY. (12 Sep 1972).

A summary is presented of the calculation methods and the relationship to the actual shielding design of the Fast Test Reactor (FTR). Particularly difficult shielding analysis areas are described. These areas are the reactor head bulk penetration and streaming problems, the reactor cavity source problem and streaming into adjacent pipeways and main heat transport cells. The methods of resolution of these problem areas are presented. (auth)

55384 (CONF-720901–(Bks.1 and 2), pp 613-22) USE OF CFRMF INTEGRAL DATA IN CROSS SECTION EVALUATIONS. Harker, Y. D.; Turk, E. H. (Aerojet Nuclear Co., Idaho Falls, Idaho). 1972.

From Meeting on new developments in reactor physics and shielding calculations; Kiamesha Lake, NY. (12 Sep 1972).

The Coupled Fast Reactivity Measurement Facility (CRFMF) is being used in evaluating neutron cross section data files for the neutron energy range from 1 keV to 1 MeV. The main materials being studied are fission product isotopes where little or no differential data are available. Two methods of measurement are used, capture measurements and reactivity measurements. The results are combined with semi-empirical model calculations to produce evaluated files of differential cross section values. The evaluation methods described are expected to reduce overall uncertainties in fission product cross sections from 40% to less than 10%. This reduction would result in significant reductions in the uncertainties of the important parameters of a Liquid Metal Fast Breeder Reactor and the final overall uncertainties would fall within the acceptable limits as established in literature. 10 references. (auth)

55385 (CONF-720901–(Bks.1 and 2), pp 623-35) EVALUATION AND INTERPRETATION OF INTEGRAL EXPERIMENTS IN FAST CRITICALS. Kiefhaber, Edgar (Kernforschungszentrum, Karlsruhe, Ger.). 1972.

From Meeting on new developments in reactor physics and shielding calculations; Kiamesha Lake, NY. (12 Sep 1972).

Clean integral experiments are examined because they are of general interest and use compared to the rather limited applicability of mock-up experiments. The different approaches to using the information obtained from integral experiments are indicated. The activities at Karlsruhe to improve the nuclear data and methods of calculation are described, with special emphasis on some of the more recent results. First, the improvements in the group constant sets are considered; this is followed by studies of more specific problems, such as the influence of the energy dependence of the fission neutron spectrum, or the difficulties encountered in calculating the reactivity coefficients of reactor materials. 21 references. (auth)

55386 (CONF-720901–(Bks.1 and 2), pp 636-44) MONTE CARLO CALCULATIONS FOR THE CRITICAL EXPERIMENT OF THE GERMAN INCORE THERMIONIC REACTOR. Schmidt, F. A. R.; Bernnat, W.; Dagbjartsson, S. (Institut fuer Kernenergetik, Stuttgart). 1972.

From Meeting on new developments in reactor physics and shielding calculations; Kiamesha Lake, NY. (12 Sep 1972).

A critical facility for the German Incore Thermionic Reactor (ITR) was established at the Jülich Nuclear Research Center. Various measurements were performed at this facility. Partly they have to be analyzed by Monte Carlo. This is done using the multigroup Monte Carlo Code MORSE-K. A short description of this code is given. Among the tasks which had to be solved were the investigation of various cross section libraries, the discussion of geometrical details necessary to describe the facility in calculations and the determination of reactivity worths of different materials at different positions in the reactor. The principal approaches to solve these problems are described. First results are given and discussed. (auth)

55387 (CONF-720901–(Bks.1 and 2), pp 645-59) EXPERIMENTAL RESULTS FROM TWO Pu-FUELED FAST CRITICAL ASSEMBLIES. Boehme, R.; Fischer, E. A.; Mc Grath, P. E.; Scholtyssek, W. (Kernforschungszentrum, Karlsruhe, Ger.). 1972.

From Meeting on new developments in reactor physics and shielding calculations; Kiamesha Lake, NY. (12 Sep 1972).

Two Pu-fueled fast critical assemblies of different enrichment were studied in the Karlsruhe Fast Critical Facility SNEAK to test cross section data and calculational methods. The measurements suitable for this purpose are central reaction rates and reactivity worths. In addition, measurement of the core material buckling, which characterizes the core material independent of its geometry and surroundings, was also included. The measurement procedures employed are described in some detail. The evaluation of these measurements was done with the most recent cross section sets and computer codes available at Karlsruhe. A portion of the experiments were also calculated with a cross section set based on ENDF/B data. 8 references. (auth)

55388 (CONF-720901–(Bks.1 and 2), pp 660-86) IMPACT OF THE NEW LASL DELAYED NEUTRON DATA ON FTR DESIGN. Ramchandran, S.; Birney, K. R. (Westinghouse Advanced Reactors Div., Madison, Pa.). 1972.

From Meeting on new developments in reactor physics and shielding calculations; Kiamesha Lake, NY. (12 Sep 1972).

Three different sets of delayed neutron parameters were used for evaluating β_{eff} and the lhs to $\%\Delta k/k$ conversion factor in FTR and its criticals. The impact of using different delayed neutron data in the analysis of critical experiments and FTR design is discussed. The new delayed neutron parameters have particular significance in determining the ^{10}B poison loading in FTR control rods resulting in a potential improvement in the lifetime characteristics of the poison assemblies. 18 references. (auth)

55389 (CONF-720901–(Bks. 1 and 2), pp 700-12) MEASUREMENT OF β_{eff} IN Pu-FUELED FAST CRITICAL ASSEMBLIES. Boehme, R.; Fisher, E. A.; McGrath, P. E. (Kernforschungszentrum, Karlsruhe, Ger.).

From Meeting on new developments in reactor physics and shielding calculations; Kiamesha Lake, NY. (12 Sep 1972).

The effective delayed neutron fraction, β_{eff}, and the normalization integral were measured in two mixed-oxide fueled fast critical assemblies, using the apparent reactivity of a ^{252}Cf-source, and traverses of reaction rates. In addition, ratios of β_{eff} values of different isotopes were measured by studying effect of the transport of delayed neutron precursors with a pile oscillator. The evaluation of these measurements was done with the most recent cross section sets available at Karlsruhe. The experiments give larger β_{eff} values than those calculated with Keepin's data, and indicate that the difference is mainly due to β of ^{239}Pu and, to a lesser extent, to β of ^{238}U. 9 references. (auth)

55390 (CONF-720901–(Bks.1 and 2), pp 739-67) ANALYSIS OF SODIUM-VOID EXPERIMENTS IN THE FTR ENGINEERING MOCKUP CRITICAL ASSEMBLY. Travelli, A.; Beitel, J. C. (Argonne National Lab., Ill.). 1972.

From Meeting on new developments in reactor physics and shielding calculations; Kiamesha Lake, NY. (12 Sep 1972).

A series of sodium-void experiments in the engineering mockup critical assembly of the FTR (FTR-EMC) is analyzed. The computational model is based on X-Y diffusion perturbation theory with ENDF/B-I data. The analytical procedure yields results in excellent agreement with the experiments and provides a demonstrated tool for the prediction of other sodium-void effects. In addition, the results indicate that the gross heterogeneities of the FTR core, including control rods, sodium channels and test loops, exert an overwhelming influence on the spatial distribution of the sodium-void coefficient throughout the FTR core. 13 references. (auth)

55391 (CONF-720901–(Bks.1 and 2), pp 839-87) FTR NEUTRONICS: STATUS, PROBLEMS, AND DEVELOPMENT PROGRAMS. Hofmann, P. L. (Hanford Engineering Development Lab., Richland, Wash.). 1972.

From Meeting on new developments in reactor physics and shielding calculations; Kiamesha Lake, NY. (12 Sep 1972).

The nuclear design features of the FTR and the more significant nuclear problem areas are discussed. A description of the nuclear development programs is given and their impact on FFTF design decisions is assessed. Finally, a brief discussion of the plans for nuclear startup and for the Irradiation Test Program is presented. 93 references. (auth)

55392 (CONF-720901–(Bks.1 and 2), pp 973-85) SODIUM VOID STUDIES AND RELATED HETEROGENEITY EFFECTS IN ZPPR-2, THE BENCHMARK DEMONSTRATION ASSEMBLY. Palmer, R. G.; Davey, W. G.; Collins, P. J.; Amundson, P. I.; Kaiser, R. E.; Beck, C. L. 1972.

From Meeting on new developments in reactor physics and shielding calculations; Kiamesha Lake, NY. (12 Sep 1972).

Sodium reactivity experiments in the ZPPR-2 critical assembly are described. The problems in relating the measurements to a large power reactor are discussed from the aspect of differences in heterogeneity in the cores. (H.D.R.)

55393 (CONF-720901–(Bks.1 and 2), pp 1006-15) EFFECT OF CORE CONFIGURATION ON ^{238}U DOPPLER MEASUREMENTS IN ZPPR ASSEMBLY 2. Kaiser, R. E.; Gasidlo, J. M. 1972.

From Meeting on new developments in reactor physics and shielding calculations; Kiamesha Lake, NY. (12 Sep 1972).

From the data on the sodium-void comparisons and the heterogeneity comparisons on natural UO_2 samples in ZPPR-2, it would appear that the effects of both can be calculated reasonably well, and that the heterogeneity effect is small. The Doppler reactivities, however, are calculated with two to three times the accuracy of the gross sample worths and the ^{238}U small-sample measurements. There are at least two possible factors to explain this phenomenon; (1) the discrepancy in the gross worth calculation is due to a non-resonance component of the cross-section, (2) the hot-cold interaction between the sample and the surrounding core leads to a slight distortion of the measurements. 8 references. (auth)

55394 (CONF-720901–3) FFTF PIPE CHASE STREAMING EXPERIMENT. McGregor, B. J.; Muckenthaler, F. J. (Oak Ridge National Lab., Tenn.). 1972. 12p. Dep. NTIS.

From Meeting on new developments in reactor physics and shielding calculations; Kiamesha Lake, NY. (12 Sep 1972).

The present FFTF reactor design includes sodium inlet and outlet pipes which penetrate the 4-ft-thick reactor cavity wall at a height of approximately 19 ft above the top of the core. Most neutrons enter these pipe chases at a slant angle and streaming subsequent to scattering in the chase contributes an important source of neutrons to the heat exchanger vaults. Streaming of neutrons can take place along the sodium in the pipes as well as along the clearance gaps and along the low-density insulation surrounding the pipes. Experiments were designed to validate analytical methods which will be used to predict the flux levels in the heat exchanger vault and piping. The experimental calculation reported on was a steel-lined concrete pipe chase and sodium-filled pipe mockup placed in a collimated neutron beam at an angle of 60 deg. (auth)

55395 (CONF-720901–12) SUMMARY OF ANALYSES OF PLATE VS. PIN MEASUREMENTS EMPHASIZING REACTIVITY AND SODIUM VOID EFFECTS. Pitterle, T. A.; Paik, N. C. (Westinghouse Electric Corp., Madison, Pa. Advanced Reactors Div.). 1972. Contract AT(11-1)-3045. 31p. Dep. NTIS.

From Meeting on new developments in reactor physics and shielding calculations; Kiamesha Lake, NY. (12 Sep 1972).

Analyses of measurements performed in pin and plate environments of nearly identical composition in critical assemblies ZPPR-2 and ZPR-6-7 are presented. Plate environment of critical assemblies introduces heterogeneity effects which differ significantly from that of an LMFBR which is comprised of fuel pins typically about $^1/_4$ inch in diameter. Consequently, the recent pin versus plate measurements are an important contribution to removing uncertainties in the extrapolation from plate critical measurements and analyses to the LMFBR pin environment. (13 references) (auth)

55396 (EURFNR–1014) CALCULATION OF HETEROGENEOUS FLUXES, REACTION RATES, AND REACTIVITY WORTHS IN THE PLATE STRUCTURE OF ZERO POWER FAST CRITICAL ASSEMBLIES. McGrath, P. E.; Fischer, E. A. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Reaktorphysik). Mar 1972. 64p. (KFK–1557). Dep. NTIS (U. S. Sales Only).

Work performed under United States–Euratom Fast Reactor Exchange Program.

The methods utilized in the computer program KAPER (Karlsruhe Perturbation Evaluation Routine) are presented. The program is a multigroup cell code for the calculation of cross sections, fluxes, reaction rates, and small-sample reactivity worths in the plate geometry of zero power critical assemblies. The methods in the program are based on integral transport theory in the collision probability formulation. The resonance self-shielding of the cross sections in the multiregion cells is calculated with a formulation based on the f-factor concept. The program has the unique feature of treating local perturbations in the normal unit cell in which the local properties of the cell have been changed as a result of the experiments. Small-sample reactivity worths are found with perturbation theory in which the perturbed flux in the sample and environment is used. Application of the program in the analysis of measurements performed in the zero power critical facility SNEAK at Karlsruhe is described. The measurements include reaction rates and small-sample reactivity worths. (17 references). (auth)

55397 (EURFNR–1016) KFKINR-SET OF GROUP CONSTANTS; NUCLEAR DATA BASIS AND FIRST RESULTS OF ITS APPLICATION TO THE RECALCULATION OF FAST ZERO-POWER REACTORS. Kiefhaber, E. (comp.) (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). Mar 1972. 81p. (KFK–1572). Dep. NTIS (U. S. Sales Only).

Work performed under United States–Euratom Fast Reactor Exchange Program.

The preparation of the MOXTOT-set in 1969 was a first step in the desired direction of improving the group constants used for nuclear calculations of fast reactors. Using this data-set, it was possible to predict the criticality of all zero-power reactor-assemblies studied as test cases at that time within an uncertainty limit of ± 2% Further improvements superseding the MOXTOT-set have been necessary in order to reduce the uncertainty range for the criticality prediction and to improve the prediction of other important quantities besides criticality, e.g., reaction rates which are important for the breeding properties of fast power reactors. For the test of the improved set of group constants, named KFKINR-set, the same critical assemblies which were taken for the test of the preceding MOXTOT-set are used. The important changes in the group constants with respect to the MOXTOT-set, which was used as starting point, concern mainly the heavy isotopes which are important for fast breeder reactors, especially Pu239, U238, U235, and Pu240. For the determination of the group constants for the elastic down-scattering we have used as the weighting spectrum the collision density of a typical sodium cooled fast reactor, namely that of the SNR. The complete nuclear data basis of the improved group constants is described. First results for the recalculation of fast critical assemblies are presented. Some essential characteristics of the new set of group constants and the results obtained by its first test applications are summarized. (69 references) (auth)

55398 (EURFNR–1029) PHYSICS INVESTIGATIONS OF SODIUM COOLED FAST REACTORS SNEAK-ASSEMBLIES 6A/6B. Jourdan, G.; Plum, F.; Reichel, H. (Kernforschungszentrum, Karlsruhe (West Germany)). Jun 1972. 99p. (KFK–1612). Dep. NTIS (U. S. Sales Only).

Work performed under United States–Euratom Fast Reactor Exchange Program.

SNEAK Assembly 6 was aimed at measuring physics parameters of a fast sodium cooled breeder core having a number of features typical for the prototype SNR. Whereas in SNEAK-Assembly 2 /1/ particular attention was given to a close simulation of the radial geometry, in SNEAK-Assembly 6 the axial behavior of the prototype SNR was simulated and studied. SNEAK-Assembly 6 had three modifications SNEAK-6A, SNEAK-6B and SNEAK-6D. SNEAK-6A has three zones, an inner Pu-zone with SNEAK material, a buffer zone composed of MASURCA rod material and the outer uranium zone. SNEAK-6B had the same zones without the buffer zone; in both assemblies some identical experiments were performed for studying the influence of the buffer zone. SNEAK-6D was a core with an inner Pu-zone with MASURCA material, a buffer zone, and a uranium driver zone. In this case, the buffer zone was composed of SNEAK-material. The influence of the material geometry on some experiments was studied by comparing the results of these experiments in SNEAK-6A and 6D. The experimental results were compared to detailed calculations. (19 references) (auth)

55399 (IKF–27) EXPOSURE OF PERSONS AFTER WATER LOSS IN THE TANK OF THE FRF2 REACTOR. Wensel, A. (Frankfurt Univ. (West Germany). Institut fuer Kernphysik). Apr 1972. 19p. (In German). Dep. NTIS (U. S. Sales Only).

Water level in the FRF2 tank as a function of time after damage to a primary coolant pipe is calculated. The core is bared after 25 sec. Dose rate on the surface of the upper shield plug (50 cm Fe) 25 sec after shutdown is 40 m Rem/h. If the shield plug is not in place exposure of persons is possible by backscattering at the reactor hall ceiling. Calculations using the Chilton–Huddleston formula for exposure albedo indicate that the dose rate at a lateral distance of 1 m from the tank is 2.5 Rem/h. Results of measurements of exposure albedo using a ^{60}Co source agree with calculated data. 6 references. (auth)

55400 (JAERI-M-4630) OPERATION REPORT ON THE LOW TEMPERATURE FISSIOCHEMICAL LOOP (JTFL). I. TEST OPERATIONS DURING THE PERIOD OF APRIL 1969 TO MARCH 1970. Sato, Shoichi; Moriyama, Noboru; Danno, Akibumi; Sukegawa, Tomohide; Oshima, K. (Japan Atomic Energy Research Inst., Tokyo). Nov 1971. 17p. (In Japanese). NTIS (U. S. Sales Only).

The Low Temperature Fissiochemical Loop (LTFL) has been operated seven times for out-pile and in-pile tests, during F.Y. 1969–1970. Operational characteristics of the loop were measured, evaluated and compared with the design calculations, including pressure loss and temperature distribution along the helium coolant piping, performance of the instruments, and thermal effects of reactor radiation on the capsule and in-pile plug of the loop. It was found that the loop can be operated with sufficient safety for the irradiation of chemical reaction systems in the presence of fissionable materials as designed. (auth)

55401 (JAERI-Memo-3891) CRITICAL EXPERIMENTS ON FCA I-6. Nakano, Masafumi; Hiraoka, Toru; Nakamura, Tomoo (Japan Atomic Energy Research Inst., Tokyo). Jan 1970. (In Japanese). NTIS (U. S. Sales Only).

Critical experiments were carried out on a 20% enriched uranium metal core with a graphite reflector of 25 cm thickness named FCA I-6. This core was built as one of the assemblies at which a series of pulsed neutron experiments was performed to study the kinetics of two-region fast systems. The critical mass of the assembly is 78 ± 1 kg of ^{235}U. This value is about 10% less than that of FCA I-1, a 20% EU core with 30 cm natural uranium metal blanket. The values of fission ratios at the core center show little discrepancy to those of a 20% EU bare system, FCA I-5. The neutron spectrum at the center of the 20% EU core is almost independent of the kind of reflectors. From the results of the reaction rate traverse by the detectors of different energy response, it became clear that the neutron spectrum in the reflector was quite different from that in the core. However, only a small variation in the neutron spectrum is observed in the central zone of each region. (Japan)

55402 (JAERI-Memo-4002) CONSTRUCTION OF THE JRR-1. (Japan Atomic Energy Research Inst., Tokyo). 1 May 1970. (In Japanese). NTIS (U. S. Sales Only).

JRR-1 was the first reactor to be constructed in Japan; it went critical on Aug. 27, 1957. The reactor was made by Atomics International in the United States. The procedure leading to the completion of JRR-1, including the construction works performed, is described. (auth)

55403 (JAERI-Memo-4004) SEMI-EXPERIMENTAL MEASUREMENT OF EFFECTIVE DELAYED NEUTRON FRACTION OF A FAST REACTOR SYSTEM BY APPLICATION OF PULSED NEUTRON TECHNIQUE. Hiraoka, Toru; Nakano, Masafumi; Konishi, Toshio (Japan Atomic Energy Research Inst., Tokyo). Apr 1970. (In Japanese). NTIS (U. S. Sales Only).

The effective delayed neutron fraction of FCA I-5 was measured by applying the pulsed neutron technique and the eigenvalue calculation checked by the critical experiments. The reactivity change due to the distribution of small voids in the core was measured. The distribution of small voids causes the change of the leakage characteristics. The reactivity change was estimated in the unit of $\Delta K/K$ by eigenvalue calculations. From the ratio between then, it is possible to compute the β_{eff} directly. The effective delayed neutron fraction of FCA I-5 thus obtained is $(7.09 \pm 0.12) \times 10^{-3}$. (auth)

55404 (JAERI-Memo-4052) SUMMARY OF THE JRR-2 IN-CORE IRRADIATION FACILITY AND IRRADIATION EXPERIENCES. (Japan Atomic Energy Research Inst., Tokyo). 31 May 1970. (In Japanese). NTIS (U. S. Sales Only).

A summary of the JRR-2 in-core irradiation facility and irradiation experiences for the past years is presented. The JRR-2 core consists of 22 MTR type fuel (^{235}U content 195 gr/element) and 2 cylindrical fuel elements (^{235}U content 120 gr/assembly). Dimensions of in-core irradiation capsule are 34 mm dia. × about 700 mm long. The capsule is inserted into center hole in cylindrical fuel element. (auth)

55405 (JAPFNR-43) PRELIMINARY CONCEPTUAL DESIGN OF JOYO MK-II IRRADIATION APPARATUS. (Tokyo Shibaura Electric Co. Ltd., Kawasaki, Kanagawa Prefecture (Japan)). Translation of report PNC-N-141-72-1-13. 12p. Dep. NTIS (U. S. Sales Only).

For Power Reactor and Nuclear Fuel Development Corp., Tokyo (Japan).

PNC has a plan to set up the irradiation facilities in the experimental fast reactor JOYO around 1978 as one of the important programs of JOYO MK-II Project. The preliminary conceptual design is described. (auth)

55406 (NASA-TM-X-2440, pp 618-19) SPACE RADIATION STUDIES AT THE WHITE SANDS MISSILE RANGE FAST BURST REACTOR. De La Paz, A. (Army Missile Test and Evaluation, White Sands Missile Range, N. Mex.). Jan 1972.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

The operation of the White Sands Missile Range Fast Burst Reactor is discussed. Space radiation studies in radiobiology, dosimetry, and transient radiation effects on electronic systems and components are described. Proposed modifications to increase the capability of the facility are discussed. (auth)

55407 (ORNL-TM-3769) STUDY OF REACTIVITY BALANCE DURING STARTUP OF THE HFIR. Allen, J. W.; Sides, W. H. Jr. (Oak Ridge National Lab., Tenn.). Aug 1972. Contract W-7405-eng-26. 16p. Dep. NTIS.

The reactivity balance during startup in the High Flux Isotope Reactor calculated by a mathematical model on a CDC 1700 on-line computer was studied. The balance was improved by postulating a new reactivity term due to a power coefficient (temperature feedback) and one due to the burn-out of a target poison, ^{135}Xe. (auth)

55408 (ORNL-TM-3949) BULK SHIELDING FACILITY QUARTERLY REPORT, APRIL, MAY, AND JUNE OF 1972. Tabor, W. H.; Hurt III, S. S.; Lance, E. D. (Oak Ridge National Lab., Tenn.). Sep 1972. Contract W-7405-eng-26. 23p. Dep. NTIS.

The BSR operated at an average power level of 1879 kW for 38.9% of the time during April, May, and June. Water-quality control in both the reactor primary and secondary cooling systems was satisfactory. There were no unscheduled shutdowns during the quarter. The BSR was operated at low and variable power during this quarter for 51.6 hrs to provide training for nuclear engineering students. The PCA was operated 11 days during this quarter. (auth)

55409 (RD/B/N-2272) ZERO ENERGY REACTOR FACILITY AT B.N.L., 1972. Clarke, R. W.; Heaven, S. H.; Staniland, R. J.; Walsh, M. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). May 1972. 26p. (BNLSC-63). Dep. NTIS (U. S. Sales Only).

A zero energy reactor facility at the Berkeley Nuclear Laboratories is capable of accommodating a graphite moderated reactor, fueled with low enrichment uranium (<7% ^{235}U) in the form of the Mk. I, Mk. II or Mk. III G.C.R. concept. Provision is also available for handling low enrichment plutonium bearing ceramic fuel. The first Mk. III type reactor constructed in the facility is described in detail, including the automatic and administrative controls which, while preserving normal safety procedures, were planned to meet the flexibility of core design required for a variety of experiments. Improvements made to make the facility suitable for the new program were: a greatly extended control system; the ability to handle plutonium bearing ceramic fuels; changes in control logic for more flexibility; and improve ergonomic design of the control room layout. (auth)

55410 HIGH FLUX FRANCO–GERMAN REACTOR. CIVIL ENGINEERING AND CONFINEMENT OF THE REACTOR BUILDING. Levet, R. (CEN de Saclay, Gif-sur-Yvette, France). Bull. Inform. Sci. Tech. (Paris); No. 165, 77-85(Dec 1971). (In French).

The civil engineering aspects of the plant are dependent upon the characteristics of site, which were determined by meteorology, soil structure investigations, hydrology and seismology. The HFR building is designed to house the reactor and its installations, to provide a containment in relation to the exterior, and to provide an internal containment affording the appropriate degree of protection at the different levels, and for the different uses of the reactor. Calculations indicate that the inner concrete envelope is capable of supporting an internal pressure overload in excess of that which would be produced by the maximum accident (120mbar). The gas leak rate towards the outside is considerably reduced by the double concentric envelope within which fresh air is maintained at a pressure in excess of that likely to be produced in the inner envelope

in the case of an accident, the rapid shutting off of the valves isolating the ventilation system. The waste evacuated by the chimney, after crossing the filters and vacuum traps, varies with the radioactivity of confined air. Internally, the places subjected to tritium contamination risks are isolated by pressure differences such that these areas are protected from any contamination arising in the operation area. (France)

55411 HIGH FLUX FRANCO–GERMAN REACTOR. SAFETY ASPECTS. Bureau du Colombier, J. (CEN de Saclay, Gif-sur-Yvette, France); Reutler, H. Bull. Inform. Sci. Tech. (Paris); No. 165, 87–93(Dec 1971). (In French).

A classical material, whose characteristics under similar conditions were known, was chosen for the construction of the reactor. In the transition region, the power evacuation from the core of the reactor is assured with a minimum margin of 1.25 (1.5 in operation) in relation to the flow redistribution phenomenon in the fuel element cooling channel. The primary circuit and the associated equipment are designed so that under no circumstances can the reflector be emptied and the core left exposed. The double confinement avoids any possible contact between the air and the deuterium of the cold source in the case of the failure of one of the walls. A double enclosure with an interspace containing He under pressure prevents any contact between the water and graphite of the hot source. The swimming pool walls are capable of undergoing a plastic deformation sufficient to absorb most of the mechanical energy generated during a major accident. The reactor confinement vessel also has a double envelope (concrete inner protection wall, stainless steel outer wall, an excess pressure maintained in the space between the walls). (France)

55412 HIGH FLUX FRANCO–GERMAN REACTOR. PRESENTATION OF THE REACTOR AND ITS PRINCIPAL CHARACTERISTICS. Chatoux, J. (CEN de Grenoble, France). Bull. Inform. Sci. Tech. (Paris); No. 165, 9–26(Dec 1971). (In French).

The importance of neutron experiments is recalled and their possible applications are reviewed. A survey of the performance required from a high flux reactor acting as a neutron source is presented together with the principal characteristics. (France)

55413 SIGNALING SYSTEM FOR PNEUMATIC INSTALLATIONS IN NUCLEAR REACTORS. Dieck, Enoui Leopold (to Kernforschungsanlage). U. S. Patent 3,681,194. 1 Aug 1972. Priority date 9 Mar 1968, Germany.

A pneumatic-tube installation for positioning a sample in the flux of a reactor is provided with a metallic tube extending from a stop for the sample. An electro-acoustical transducer, preferably a microphone, is disposed along the tube at a location outside the reactor core to detect the sound wave transmitted along the tube upon engagement of the sample with the stop. The output of the transducer is applied through a variable-threshold (amplitude comparator) trigger circuit (Schmitt trigger) to a switching device whose output, in turn, can initiate a timing cycle. An optical detector ahead of the microphone is connected through an AND-gate designed to enable the switching device so that the system responds only at the sound of impact with the stop. (Official Gazette)

55414 HIGH FLUX FRANCO–GERMAN REACTOR. THE COLD NEUTRON SOURCE OF THE HIGH FLUX REACTOR. Ageron, P. (Institut Max von Laue–Paul Langevin, Grenoble, France); Astruc, J. M.; Geipel, H.; Verdier, J. Bull. Inform. Sci. Tech. (Paris); No. 166: 17–22(Jan 1972). (In French).

The reasons why a liquid deuterium source was chosen as a very low energy neutron source are analyzed. A description of the main elements of this cold source is then given: dueterium circuit containing 8 kg D_2 (4 kg of which are liquefied); helium refrigerator having a power of 10 kW between 18.6 and 24.5K; control panels. The working principle of the cold source, which has a very simple design ensuring maximum reliability, is examined. (France)

55415 HIGH FLUX FRANCO–GERMAN REACTOR. COOLING CIRCUITS AND DETRITIATION INSTALLATION. Chazalon, M.; Lecuyer, Y. (CEN de Saclay, Gif-sur-Yvette, France). Bull. Inform. Sci. Tech. (Paris); No. 165, 57–66(Dec 1971). (In French).

The principle of the cooling circuits is as follows: a primary circuit which is completely contained in a containment vessel transfers power directly, using classical exchangers, to a secondary circuit. The primary circuit contains heavy water for the core circuits, and demineralized water for the swimming pool and channel circuits. The secondary circuit is an open circuit using water pumped from and evacuated back into the Drac River. A complete diagram is given for these circuits. The utilization of the different parts of the cycle is discussed: the power region, the stopping region, and the natural convection region. The different equipment is also described: exchanger pumps, isolating valves, taps, tubing and materials. The detritiating installation purifies the heavy water. It is capable of eliminating 160 liters of light water/year from water having a hydrogen molar content of 0.004. A tritium diminution of 2.78 for the heavy water is assured, thus enabling an equilibrium activity of 3Ci/liter instead of 80 Ci/liter (without detritiation) to be obtained. A production of 6.87 Nml/h is obtained with a 0.99 ratio. The equipment consists of two principal parts, operating a catalytic exchange and a fractional distillation respectively. (France)

Reactor Components, Fuels, and Accessories

Refer also to abstracts 53204, 53555, 53559, 53562, 53563, 53565, 53566, and 53605.

55416 (BNWL–1522–5) AEC REACTOR DEVELOPMENT AND TECHNOLOGY PROGRAMS. Technical Activities Report, October–December 1971; January–March 1972. (Battelle Pacific Northwest Labs., Richland, Wash.). May 1972. Contract AT(45-1)-1830. 66p. Dep. NTIS.

The high temperature Lattice Test Reactor, successfully operated for 4 years in support of high-temperature gas-cooled and molten-salt breeder reactor development, has been defueled and is now in standby status. The reactivity effect of 25 μ PuO_2 particles relative to homogenous fuel, has been calculated. Radiolytic measurements in H_2O and CO were made. A fuel heat-transfer model was developed for inclusion in the COBRA-3B computer program. It was shown that in multi-rod bundles, velocity profile, intensity, and scale were nearly independent of Reynolds number over the range 50,000 to 200,000. Results and analyses are presented on measurements of critical parameters in PuO_2–polystyrene lattices. Correlations of experimental critical data for high burnup Pu solutions were made. ENDF/B cross section data have been checked against integral experiments for a number of fast critical assemblies. (36 references) (J.M.J.)

55417 (CONF-710959) SPECIALISTS' MEETING ON "FISSION AND CORROSION PRODUCT BEHAVIOUR IN PRIMARY SYSTEMS OF LMFBR'S SEPTEMBER 20–22, 1971, BENSBERG/FRG. Summary Report. (International Atomic Energy Agency, Vienna (Austria)). 1971. 232p.

Eighteen papers were presented at the conference. A separate abstract was prepared for each of seventeen papers. It is suggested that cesium is the major contributor to long-term activity. This does not appear to deposit in quantity, but more studies are required to substantiate its behavior and whether it can be cold trapped. There is a lack of information in the release fraction and behavior of iodine and tellurium. (J.M.J.)

For abstracts of individual papers see: 52895, 53121, 55162–55173, 55185, 55226, and 55381.

55418 (GEAP–13788) BEHAVE-2: OXIDE FUEL PERFORMANCE CODE IN TWO SPATIAL DIMENSIONS AND TIME. Oldberg, S. Jr. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Dept.). Feb 1972. Contract AT(04-3)-189. 84p. Dep. NTIS.

BEHAVE-2 is a FORTRAN 4 computer program written for the GE-635 computer. The program calculates the position in space of cladding, fuel, and voidage in an operating oxide fuel pin with unfailed cladding. Axial symmetry is assumed throughout the program. Also calculated are stress, strain, displacement, and temperature fields. Influential processes simulated include cracking of fuel, dilatation of fuel and cladding due to irradiation effects and thermal expansion, fuel densification by stress and diffusion controlled processes, axial slippage or locking at the fuel-cladding interface, and axial flow of fuel. 49 references. (auth)

55419 REACTOR FUEL ELEMENT. Rolf-Woltje (to Gesellschaft fuer Kernenergieverwertung). German Patent 1,464,645. 27 Apr 1972. (In German).

The special feature of this fuel element with high negative fuel temperature coefficient of the reactivity, containing a solid fuel and a solid moderator in one casing, is a thermal insulating layer which separates fuel and moderator from the casing. The thermal insulating layer may be a slit, the moderator may be a metal hydride, moderator and fuel may be contained in a homogeneous internal region either as a mixture or as a chemical compound. (GF)

Reactor Physics and Core Engineering

Refer also to abstract 54469.

Physics

Refer also to abstracts 54480 and 55416.

55420 (AREAEE-141) PIBIMUG: A CODE FOR MULTIGROUP SLOWING DOWN SPECTRUM CALCULATION IN THE P-1 AND B-1 APPROXIMATIONS FOR THE IBM-1130. El-Cherif, A. I.; Gaafer, M. A.; Nassar, S. F. (Atomic Energy Establishment, Cairo (Egypt). Reactor and Neutron Physics Dept.). 1972. 20p. Dep. NTIS (U. S. Sales Only).

PIBIMUG is a multigroup code for hydrogenous moderated reactors based on P-1 and B-1 approximations. The code is written in a FORTRAN II language suited for the IBM-1130 to provide a powerful nuclear design computing tool equivalent to IBM-704 computer program MUFT-4 and PHILCO-2000 computer program MUFT-5. 4 references. (auth)

55421 (BNWL-CC-2274) USER'S MANUAL FOR DASQHE. Traver, T. M. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). 15 Sep 1969. 12p. Dep. NTIS.

An improved technique has been developed to calculate the Dancoff correction for an infinite array of circular rods in square or hexagonal lattices. This technique is coded in a FORTRAN-IV and is called DASQHE. This method has been adopted for use in the thermal reactor analytical physics work. The DASQHE code was modified and coded in FORTRAN-V for use on the UNIVAC-1108 computer. 4 references. (auth)

55422 (CISE-R-243) ANALYTICAL SOLUTION OF THE TWO-SEPARABLE VARIATIONAL SYNTHESIS APPROACH FOR THE TWO-GROUP DIFFUSION r,z EQUATIONS. Bruschi, C.; Pierini, G. (Centro Informazioni Studi Esperienze, Milan (Italy)). Feb 1969. 81p. INIS.

A code is presented which synthesizes the two-dimensional two-group flux of a cylindrical reactor out of one-dimensional solutions of the diffusion equation. The two-separable approximation $\Phi_k(r,z) = u_k^{(1)}(r)\, v_k^{(1)}(z) + u_k^{(2)}(r) v_k^{(2)}(z)$ (k = 1,2) is made where $u_k^{(n)}(r)$'s are trial functions and the $v_k^{(n)}(z)$'s are weight functions. The latter ones are obtained by solving an equivalent four-group diffusion problem in the axial direction with a block-diagonal diffusion matrix. The criticality eigenvalue is that obtained from a run of the MONOS code which is fully included in the new code. The one-dimensional solutions of the two-group (radial and axial) and of the four-group (axial) diffusion problems are obtained by an analytical method. (INIS)

55423 (CISE-R-273) ITERATIVE SOLUTION OF HETEROGENEOUS EQUATIONS IN A FINITE CYLINDRICAL SYSTEM, METHOD OF HARMONICS. Bruschi, C.; Pedretti, F. (Centro Informazioni Studi Esperienze, Milan (Italy)). Sep 1968. 23p. (In Italian). INIS.

A possible approach to the solution of heterogeneous equations in a finite cylindrical system with axial dependence is presented. These equations consider a description in three groups (fast-resonance-thermal) of slowing down and account for absorptions in the epithermal group in addition to fission and thermal absorptions. Moreover the migration properties of the system are properly accounted for through a suitable scheme which interprets the heterogeneous parameters. The method of solution is that of harmonics for the treatment of the z axis. The equations can easily be extended to a multigroup scheme because of their recurrent nature. A possible iterative scheme for the solution of these equations on a digital computer is presented. (INIS)

55424 (CONF-720901-(Bks.1 and 2)) NATIONAL TOPICAL MEETING ON NEW DEVELOPMENTS IN REACTOR PHYSICS AND SHIELDING, SEPT. 12-15, 1972, KIAMESHA LAKE, NY. (American Nuclear Society (USA), Northeastern New York Section). 1972. 1207p. Dep. NTIS $15.00.

Included are 78 papers on calculation and measurement methods for use in reactor shielding and physics analyses. A separate abstract was prepared for each paper. (H.D.R.)

For abstracts of individual papers see: 53252, 54472-54480, 54523, 54566, 54597, 54653-54655, 54676, 54826, 54872, 54937-54942, 55107-55125, 55134, 55140-55144, 55356, 55382-55393, and 55425-55439.

55425 (CONF-720901-(Bks.1 and 2), pp 108-13) EFFECT OF PARTICLE SIZE ON RESONANCE CAPTURE. Goldstein, Rubin (Combustion Engineering, Inc., Windsor, Conn.). 1972.

From Meeting on new developments in reactor physics and shielding calculations; Kiamesha Lake, NY. (12 Sep 1972).

The effect that particle size has on the reactivity of a system depends mainly on the size of the particles, the volume fraction of the absorber and the dilution of the lattice. With some restrictions, the resonance integral decreases approximately linearly with increasing particle size. An analytic expression is used that permits a rapid calculation of the effect of particle size on resonance absorption. The mathematical formulation for particularized resonance integrals gives results which are in excellent agreement with experiments performed on gold particles. For the plutonium-fuel compositions and lattice dilutions considered, resonance integrals decreased by more than 10% and the overall reactivity of ESADA criticals decreased by as much as 0.4% for 25 micron particles. (auth)

55426 (CONF-720901-(Bks.1 and 2), pp 162-7) DEVELOPMENTS IN VARIATIONAL THEORY AND PERTURBATION METHODS. Lewins, Jeffery (University Coll., London). 1972.

From Meeting on new developments in reactor physics and shielding calculations; Kiamesha Lake, NY. (12 Sep 1972).

The present usage of variational and perturbation methods in reactor physics is surveyed. (auth)

55427 (CONF-720901-(Bks.1 and 2), pp 168-78) ADVANCES AND CURRENT PROBLEMS IN REACTOR KINETICS. Ott, Karl O. (Purdue Univ., Lafayette, Ind.). 1972.

From Meeting on new developments in reactor physics and shielding calculations; Kiamesha Lake, NY. (12 Sep 1972).

Advances and current problems in fast reactor dynamics are surveyed. The general problems are reviewed first in order to provide a framework for the discussion of the recent advances. Further, some results of methodological interest are presented and discussed. 16 references. (auth)

55428 (CONF-720901-(Bks.1 and 2), pp 179-94) GREEN'S FUNCTION COUPLING METHOD FOR TIME-DEPENDENT NEUTRON SLOWING DOWN IN HEAVY MEDIA. Conn, Robert; Sawan, Mohamed (Univ. of Wisconsin, Madison). 1972.

From Meeting on new developments in reactor physics and shielding calculations; Kiamesha Lake, NY. (12 Sep 1972).

A new approach based upon the coupling together via Green's functions of distinctly different calculational methods for different time-energy regimes was developed to calculate the time-dependent neutron flux slowing down in a pulsed, heavy medium. In the approach, different methods are used to solve the slowing down problem in the energy ranges where the chosen method is both advantageous and valid. The slowing down energy range (typically, 14 MeV to thermal when the standard D(t,n) He reaction is used as source) is divided into three different energy regimes where the slowing down mechanisms are distinctly different. The problem in each regime is solved differently and a Green's function approach is used to couple the solutions together. 20 references. (auth)

55429 (CONF-720901-(Bks.1 and 2), pp 195-206) MANY-RESONANCE APPROXIMATION FOR THE NEUTRON ENERGY SPECTRUM. Segev, M. 1972.

From Meeting on new developments in reactor physics and shielding calculations; Kiamesha Lake, NY. (12 Sep 1972).

A study of the effect of a resonance ensemble on the reactor neutron spectrum, based on the properties of the ensemble as a whole, is summarized. The sections present: (a) a qualitative argument for the approximation, (b) the basic formulas, (c) conditions for negligible oscillations in the collision density, (d) a series solution for ν, where $\exp(-\nu)$ is the relative change in the collision density per unit lethargy, (e) the generalization of the formulas for slowly varying average resonance parameters, (f) numerical tests of the approximation. (auth)

55430 (CONF-720901-(Bks.1 and 2), pp 207-10) PREDETERMINING STATISTICAL ERRORS IN MONTE CARLO TRANSPORT CALCULATIONS. Amster, Harvey J. (Univ. of California, Berkeley). 1972.

From Meeting on new developments in reactor physics and shielding calculations; Kiamesha Lake, NY. (12 Sep 1972).

The use of ordinary adjoint transport codes to provide statistical error estimates of problems to be run on contemplated Monte Carlo codes is discussed. This would allow the accuracy of a Monte Carlo calculation to be estimated before a code is developed. (H.D.R.)

55431 (CONF-720901-(Bks.1 and 2), pp 229-39) ZERO VARIANCE ESTIMATOR FOR REACTOR CRITICALITY. Kalos, M. H. (New York Univ., N. Y.). 1972.

From Meeting on new developments in reactor physics and shielding calculations; Kiamesha Lake, NY. (12 Sep 1972).

A scheme is proposed for biasing in the Monte Carlo solution of reactor criticality problems. Under ideal conditions which require knowledge and correct use of an "adjoint fission neutron distribution" it leads to zero variance estimates of the reactor eigenvalue and other quantities. Also discussed are practical ways of obtaining and representing numerical information about this

adjoint function. Of particular interest is the fact that estimates of the needed information for biassing can be obtained as a by-product in the course of an ordinary or biassed calculation. As the biassing is improved, the efficiency with which such estimates are made can be made arbitrarily high. Numerical results from the Monte Carlo solution of a simplified problem are presented to support the anticipation that computing time can be significantly reduced even when perfect biassing is not used. (auth)

55432 (CONF-720901–(Bks.1 and 2), pp 240-51) DETERMINATION OF OPTIMAL K-INFINITY MISMATCH CURVES VIA MODERN CONTROL THEORY. Terney, William B.; Wade, David C. (Knolls Atomic Power Lab., Schenectady, N. Y.). 1972.

From Meeting on new developments in reactor physics and shielding calculations; Kiamesha Lake, NY. (12 Sep 1972).

The problem of determining the burnup dependence of k_∞ in the loading zones of a reactor core so as to yield the best reactor performance throughout life is treated as an optimal control problem. An iterative solution scheme based on a gradient approach is derived for solving the resulting two point boundary value equations. Results from sample calculations on realistic design models demonstrate the validity and usefulness of the approach. (auth)

55433 (CONF-720901–(Bks.1 and 2), pp 253-65) SIMULTANEOUS LINE OVER-RELAXATION (SLOR) IN HEXAGONAL LATTICE. Honeck, H. C.; Stewart, J. W. (Savannah River Lab., Aiken, S. C.). 1972.

From Meeting on new developments in reactor physics and shielding calculations; Kiamesha Lake, NY. (12 Sep 1972).

A Simultaneous Line Over-Relaxation (SLOR) method was developed for the solution of the one-group difference form of the neutron diffusion equation in regular hexagonal lattices. This method was successfully implemented as a part of a hex-z geometry, multigroup diffusion theory module in the Generalized Reactor Analysis Sub-System (GRASS) of JOSHUA. The theory and equations for this SLOR method and some results are presented. (auth)

55434 (CONF-720901–(Bks.1 and 2), pp 266-74) OPTIMUM ANGULAR SEGMENTATIONS IN NEUTRON TRANSPORT ANALYSIS. Harms, A. A.; Garland, W. J. (McMaster Univ., Hamilton, Ont.). 1972.

From Meeting on new developments in reactor physics and shielding calculations; Kiamesha Lake, NY. (12 Sep 1972).

The problem of specifying optimum angular segmentations in neutron transport analysis is considered. A new directional-group representation using partial-range Legendre polynomials is introduced for this purpose. It is found that this solution formalism can be used to specify angular segmentations which minimize the error of certain neutron transport parameters for a given order of approximation. 9 references. (auth)

55435 (CONF-720901–(Bks.1 and 2), pp 275-92) IMPROVED S_N INNER ITERATION CONVERGENCE CRITERION. Atkinson, Gerald L. (Pentagon, Washington, D. C.); Kerr, William; Dunderstadt, James J. 1972.

From Meeting on new developments in reactor physics and shielding calculations; Kiamesha Lake, NY. (12 Sep 1972).

The angular flux form of the S_N equations in plane geometry is formulated within a mathematical framework which allows an insight into the mechanics of the convergence process. The infinity-norm of the S_N iteration matrix is explicitly calculated for a problem with a homogeneous isotropically scattering medium. This event allows the calculation of an improved convergence criterion compared to the conventional criterion. This new criterion, along with the demonstrated convergence properties of the S_N algorithm, guarantees that the fractional iterative error is arbitrarily small. (auth)

55436 (CONF-720901–(Bks.1 and 2), pp 599-612) USE OF DATA FROM FAST ASSEMBLIES FOR ADJUSTMENTS OF NEUTRON DATA. Haeggblom, H. (Aktiebolaget Atomenergi, Studsvik, Sweden). 1972.

From Meeting on new developments in reactor physics and shielding calculations; Kiamesha Lake, NY. (12 Sep 1972).

A series of calculations was made for obtaining adjusted neutron data by a simultaneous consideration of a large number of integral data from fast reactors. In the first stage, sensitivities of k_{eff} and reaction rate ratios to changes in neutron data were calculated. The second stage consisted of a least-squares fit of calculated integral data to experimental results. The errors in the integral data and in the energy-dependent data were assumed to follow Gaussian distributions. Correlation factors were introduced between a number of energy-dependent data. The calculations were based upon 57 integral data from 31 different assemblies and give corrections for 31 neutron data divided into 6 energy groups. The Swedish neutron data library was used as the starting point, but comparisons were made between the most important data in this library and ENDF/B-II and UKNDL. The results included standard errors of the adjusted energy-dependent data, the remaining discrepancy between measured and calculated integral quantities, and the corresponding standard errors. The adjusted neutron data were compared with adjusted data obtained in Winfrith, UK. In most cases, a satisfactory agreement between the results from both laboratories was established. The most interesting result was that the adjusted fission cross section in ^{235}U and the capture cross section in ^{238}U were significantly lower than the data in ENDF/B-II over the most important part of the energy region for fast reactors. 9 references. (auth)

55437 (CONF-720901–(Bks.1 and 2), pp 713-23) VERIFICATION OF A NEW METHOD FOR CALCULATING AND MEASURING GENERATION TIME IN A SUBCRITICAL FAST REACTOR. Buhl, A. R. (Oak Ridge National Lab., Tenn.); Robinson, J. C. 1972.

From Meeting on new developments in reactor physics and shielding calculations; Kiamesha Lake, NY. (12 Sep 1972).

A new method is discussed for calculating and measuring the generation time (Λ) in a subcritical fast reactor using a recently developed transfer and scattering kinetics scheme (TASK). The method is an extrapolation of a four-node fluctuations theory in which the generation time in a thermal reactor was shown to be equal to the slope of the tangent of the phase angle from the power spectra between a high-energy-sensitive and low-energy-sensitive detector. The TASK method directly computes the prompt die-away time constant and the Λ based on the tangent method. To substantiate TASK calculations, Λ was compared with the experimental value at critical and computed Λ using the standard lambda (λ) mode and omega (ω) mode definitions for critical and for three subcritical states of the Fast Test Reactor. 10 references. (auth)

55438 (CONF-720901–(Bks.1 and 2), pp 943-58) REVIEW OF FAST NEUTRON SPECTRUM MEASUREMENTS. Presidtt, C. A. (Gulf Radiation Tech., San Diego, Calif.); Malaviya, B. K.; Bennett, E. F. 1972.

From Meeting on new developments in reactor physics and shielding calculations; Kiamesha Lake, NY. (12 Sep 1972).

Rapid advancement has taken place in the experimental technology for determining fast neutron spectra. In reactor systems, the most important techniques are neutron time-of-flight and proton-recoil proportional chambers. For certain shielding applications, other integral spectrometers are important. A wealth of experimental data is available, and most of this has been analyzed in varying degrees by the laboratories responsible for the measurements. However, the full value of the available data will only be realized when it has been widely distributed, and is analyzed using current cross sections by a larger number of groups, especially those involved in reactor design. 34 references. (auth)

55439 (CONF-720901–(Bks.1 and 2), pp 1183-91) GROUP CONSTANT GENERATION FOR THE RESOLVED RESONANCE REGION. Ruehle, R.; Emendoerfer, D.; Gulden, W.; Lutz, D. (Univ., Stuttgart). 1972.

From Meeting on new developments in reactor physics and shielding calculations; Kiamesha Lake, NY. (12 Sep 1972).

In order to check different methods for group cross section generation in the resolved resonance region, the computer code RESAB was developed. RESAB solves the slowing down Boltzmann equation in micro energy-group representation by exact first flight collision probabilities for multiregion cells with white cell boundaries. The input cross sections for RESAB are calculated as functions of energy and temperature from ENDF/B II resonance parameters and smooth data from ENDRES. Based on the same ENDF/B II cross section set, group constants were evaluated with the generally available multigroup cross section code GGC-4 in the case of a PWR pin cell. The results of RESAB- and GGC-4- calculations are discussed from a physical point of view. (auth)

55440 (INIS-mf-195) MULTIGROUP NEUTRON TRANSPORT THEORY IN PLANE GEOMETRY. Clancy, B. E. (Wollongong Univ. Coll. (Australia)). Oct 1970. 178p. NTIS.

Thesis.

The multigroup form of the transport equation describing the steady state population of neutrons in a plane geometry is studied. The existing techniques of finding numerical solutions to the transport equation in the discrete ordinate approximation are considered in relation to the deep penetration problem of reactor shielding theory. Some of the computational difficulties are examined and a major one found to be the excessive time used in iterating the equation over a large number of mesh points. A review is given of Chandrasekhar's reflection function method for finding solutions to an astrophysical problem equivalent to the one group form of the deep penetration problem in finite and semi-infinite homogeneous media. After generalizing the method it is shown how accurate solutions may be obtained for realistic multigroup problems in semi-infinite media without the need for spatial

iterations. For many deep penetration problems in finite heterogeneous slabs only certain integrals of the angular neutron fluxes emerging from the slabs are of interest. A variational principle is devised with the aid of which solutions to appropriately chosen semi-infinite medium problems can be used to calculate directly approximations to any integral of these emerging angular fluxes. From the results obtained with a computer program embodying these methods it is found that the significant savings in computing time can be achieved when a number of survey calculations need to be performed. Some possible applications of the reflection function method to other problems in neutron transport theory are examined briefly. (auth) (INIS)

55441 (LA-DC-72-660) REACTOR POWER TRANSIENT STUDIES. Stratton, W. R.; Engle, L. B.; Peterson, D. M. (Los Alamos Scientific Lab., N. Mex.). 2 Jun 1972. 14p. (CONF-721006-1). Dep. NTIS.

From International conference on engineering of fast reactors for safe and reliable operation; Karlsruhe, Germany (9 Oct 1972).

The Pajarito Dynamics (PAD) code is described in general terms. Its use for reactor power transient calculations, especially its ability of describing not only total fission energy release, but also a measure of the conversion of thermal energy to explosive energy during the power transient, is evaluated. (J.M.J.)

55442 (RT/FI-(72)11) REACTOR NEUTRON NOISE ANALYSIS: STATE OF THE ART, 1971. Pacilio, N. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 21 Mar 1972. 33p. Dep. NTIS (U. S. Sales Only).

A short presentation is given of reactor-noise time-analysis techniques. Instead of the traditional exposition of theoretical, computational and experimental problems implied in this nuclear reactor physics branch, a documentary approach is tried. The subject is treated according to the following perspectives: (1) what is noise?'', (2) prehistory of reactor-noise analysis, (3) an example of general theory, (4) some considerations on time-analysis methods, (5) recent advancements, (6) present and future directions, and (7) reactor-noise in power systems. (auth)

55443 (RT/FI-(72)13) 259 REFERENCES IN REACTOR NOISE TIME ANALYSIS. Pacilio, N. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 7 Apr 1972. 96p. Dep. NTIS (U. S. Sales Only).

An extensive reference list is given of reports, articles and books covering the matter of reactor-noise analysis in the time-domain. The comprehensive bibliography is divided into six main sections, which are entitled: monographies, surveys and general introductions; stochastic and kinetic theory; correlation analysis among neutron detection pulses; analysis of the moments of neutron distribution; analysis of the probability of a neutron detection; and correlation analysis among the signs of the power level fluctuations. Two minor sections are dedicated to gamma noise and information theory. The list is assembled according to two other criteria. First, a chronological year-after-year disposition of the various works is presented; second, an alphabetical list of authors is given and the scientific production is summarized for each of them. (auth)

55444 (TRG-2189) SPECTRA OF ENERGY RELEASED BY THERMAL NEUTRON CAPTURE. Sidebotham, E. W. (United Kingdom Atomic Energy Authority, Risley (England). Reactor Group). 1972. 8p. INIS.

Neutron capture gamma spectra are required to determine the true heat generation in reactors and its distribution over the core materials. It was observed that experimentally determined spectra although accurately determined in fine detail rarely equate to the binding energy because of a continuum of energies in the middle range. A method was devised to allocate the gamma energy spectra, corrected to the binding energy, to certain kernel energies which are of importance in determining the heating distribution in reactor core materials. Tables of thermal neutron capture gamma and radioactive decay energy spectra cover elements, compounds, alloys and fission product groups more frequently present in reactor cores. (auth) (INIS)

55445 (Y-KC-96) RELIABILITY OF CRITICALITY SAFETY CALCULATIONS USING THE NEW CODES CSC AND KENO. Crume, E. C. Jr. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). 21 Apr 1967. Contract W-7405-eng-26. 14p. Dep. NTIS.

The present state of the reliability of criticality safety calculations using the two Monte Carlo codes CSC and KENO is discussed. It is concluded that reliable system criticality calculations can be made for systems of a number of compositions of general interest in criticality safety in which the only fissile isotope is ^{235}U at high enrichment. 15 references. (auth)

55446 CONSISTENT APPROACH OF HETEROGENEOUS THEORY LEADING TO A DIPOLAR FORMULATION. I. FORMULATION. Berna, Ph. (SERMA, Gif-sur-Yvette, France). J. Nucl. Energy; 26: No. 6, 303-17(Jun 1972).

Starting from a theorem established in transport theory, a new dipolar heterogeneous formulation was developed where channels were characterized by parameters depending on the environment only through cross-sections. The formulas for these parameters could be calculated in less than 0.3 sec (by channel type) on an IBM 360/91. The FODITH code based on this formulation gave an acceptable value for the experimental reactivity of a reactor having 3 narrow zones of different scattering properties (deviation lower than 200 pcm). The code therefore gave results in better agreement with the experiment than other codes based on diffusion or source-sink theory. The new formulation appears as the extension of the ABH method initially developed for cell calculations to heterogeneous reactor calculations. (auth)

55447 CONSISTENT APPROACH OF HETEROGENEOUS THEORY LEADING TO A DIPOLAR FORMULATION. II. CALCULATION OF HETEROGENEOUS PARAMETERS. Berna, Ph. (SERMA, Gif-sur-Yvette, France). J. Nucl. Energy; 26: No. 6, 319-31(Jun 1972).

The detailed calculation of the polar and dipolar parameters used in a new consistent formulation for heterogeneous theory is presented. For the sake of simplicity it is assumed that the channel contains only two concentric media, a central fuel rod and an annular cavity, and that collisions are isotopic. (auth)

55448 IMPROVED COMPUTER METHOD FOR POLARITY CROSS CORRELATION. Cohn, C. E. (Argonne National Lab., Ill.). Nucl. Instrum. Methods; 103: No. 2, 257-9(1972).

An improved computer method for polarity-correlation noise analysis yields increased throughput and provides for monitoring of discriminator bias. (1 figure) (auth)

Core Thermal Hydraulics

55449 (KFK-1503) LAMINAR FLOW IN ROD BUNDLES. Rehme, K. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). Sep 1971. 5p. INIS.

Values for the geometrical parameter, K, in the expression lambda × Fe = K (pressure-drop law) were calculated for incompressible, isothermal, perfect laminar flow along hexagonal and square bundles of rods enclosed in hexagonal and square conduits respectively. The pressure drop in bundles consisting of a large number of rods can be calculated with the aid of K values obtained for the subchannels by numerical integration of the Navier–Stokes equation. Investigations covered a large range of rod spacings and wall separations. The result obtained are compared with data given in the literature. On the basis of the results, the pressure drop for flow in rod bundles can be calculated sufficiently accurately in all likely cases. (INIS)

GENERAL

Law

55450 (CEA-CONF-2005) USE OF PL/1 AS INTERROGATION LANGUAGE OF A DECK OF CARDS. Schauer, G. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). 19 Apr 1971. 9p. (In French). (CONF-710549-1). Dep. NTIS (U. S. Sales Only).

From 12th European conference on leading; Brussels, Belgium (11 May 1971).

55451 (LA-DC-72-626) IMAGE RESTORATION BY CONSTRAINED LEAST-SQUARES ESTIMATION. Hunt, B. R. (Los Alamos Scientific Lab., N. Mex.). 1972. 8p. (CONF-720813-1). Dep. NTIS.

From Symposium on computer image processing; Columbia, MO. (24 Aug 1972).

55452 (NP-19407) ANNUAL REPORT, 1971-72. (Department of Atomic Energy, Bombay (India)). 192p. Dep. NTIS (U. S. Sales Only).

AGRICULTURE—research in India, 1971-1972
BIOCHEMISTRY—research in India, 1971-1972
BIOLOGY—research in India, 1971-1972
CHEMICAL ENGINEERING—research in India, 1971-1972
CHEMISTRY—research in India, 1971-1972
COMPUTERS—research in India, 1971-1972
DESALTING—research in India, 1971-1972
MEDICINE—research in India, 1971-1972
METALLURGY—research in India, 1971-1972
NUCLEAR POWER—development in India 1971-1972
PHYSICS—research in India, 1971-1972
PROSPECTING—developments in India, for nuclear materials
RADIATION PROTECTION—research in India, 1971-1972
RADIOCHEMISTRY—research in India, 1971-1972
RADIOISOTOPES—research in India, 1971-1972
REACTOR FUELS—reprocessing in India, 1971-1972
REACTORS—development in India, 1971-1972
SPACE—research in India, 1971-1972 (W.H.K.)

55453 (NP-19410) FIFTEENTH ANNUAL REPORT, 1971. (Atomic Energy Board, Pretoria (South Africa)). 64p. Dep. NTIS (U. S. Sales Only).

INSTRUMENTS—development and research in South Africa, 1971
NUCLEAR PHYSICS—research in South Africa, 1971
NUCLEAR POWER—development and research in South Africa, 1971
RADIOISOTOPES—development and research in South Africa, 1971
REACTORS—development and research in South Africa, 1971
REACTORS, RESEARCH—operation of SAFARI-I, 1971
URANIUM—separation from ores in South Africa
URANIUM RESERVES—estimates in South Africa (W.H.K.)

55454 (NP-19412) RADIATION HEALTH AND SAFETY. Annual Report for the Year Ended 31st December 1971. (New South Wales Univ., Kensington (Australia)). 17p. Dep. NTIS (U. S. Sales Only).

Aspects of radiation health and safety under the auspices of the radiation protection officer are reviewed for the year 1971. These include personnel monitoring, disposal of radioactive waste, radiation incidents, radiation insurance, purchase and transfer of radioactive sources, investigations and reports on school projects and research on electrostatic collection of particular fission products and their contribution to a scintillation detector signal. (Australia)

55455 (OSU-CISRC-TR-72-8) PATTERN RECOGNITION BY RETINA-LIKE DEVICES. Weiman, Carl F. R.; Rothstein, Jerome (Ohio State Univ., Columbus. Computer and Information Science Research Center). Jul 1972. 154p.

55456 (SZS-136) 10 YEARS NATIONAL CENTER FOR RADIATION PROTECTION OF THE GERMAN DEMOCRATIC REPUBLIC. (Staatliche Zentrale fuer Strahlenschutz, Berlin (East Germany)). Aug 1972. 72p. (In German). Dep. NTIS (U. S. Sales Only).

The organization, technical and personnel conditions established in the GDR to fulfill the medical tasks in radiation protection are described. These include precautions and protective measures at the level of the individual user, as well as on a national scale, i.e., in the Division of Radiation Protection Medicine of the National Center for Radiation Protection. The necessity of close cooperation between the medical supervisors of radiation workers and the specialized clinical diagnostic installation of the Division of Radiation Protection Medicine is shown. The described system of medical supervision of persons working with radiation seems to be an appropriate countermeasure against all imaginable hazards caused by ionizing radiation to man. (G.F.)

55457 (TID-26141) APPLICATIONS OF COMPUTERS AND DIGITAL TECHNIQUES IN CLINICAL AND INVESTIGATIVE NUCLEAR MEDICINE. Erickson, Jon Jay (Vanderbilt Univ., Nashville, Tenn.). May 1972. 311p. Dep. NTIS.

Thesis.

An integrated hardware/software system for computer collection and analysis of scintillation camera radionuclide imaging data in a clinical and research oriented nuclear medicine laboratory is described. (auth)

55458 STATE OF ENFORCEMENT OF RADIATION INJURY PREVENTION LAW IN 1970. Genshiryoku Iinkai Geppo; 16: No. 10, 12-18(Oct 1971). (In Japanese).

Recently, the use of radioisotopes and radiation generating equipment has increased steadily and has become diversified in private businesses, medical treatment, research, and education. Accordingly, enforcement of the law concerning prevention of radiation injuries due to the use of radioisotopes and other radiation sources is very important. In March 1971, the number of business establishments using radiation was 2,091, an increase of 256 over the previous year. This is due to a rapid increase in the use of gas chromatography equipment and sulfur analyzers for pollution prevention measures. The establishments include 39.2% private businesses, 29.5% medical institutions, 20.4% research institutions, 7.6% educational facilities, and 3.3% others. Expansion in the private businesses is especially conspicuous. The establishments are distributed all over Japan, but ½ of them concentrate in Tokyo, Kanagawa, and Osaka. The number of the establishments for sale was 77, and that for waste disposal was six, in March 1971. The utilization of radioisotopes and other radiation sources will increase more and more hereafter, especially in the private businesses. It is predicted that radiation equipment such as thickness gauges, level gauges, and sulfur analyzers will be employed on a full scale for the purpose of production control, product control, and labor saving. The number of qualified chief radiation technicians was 8,156 in March 1971, distributed mainly in large enterprises and research institutions. Since April 1958, spot inspection was carried out in 3,690 cases according to the law. 2,887 applications and notifications were received in 1970 concerning radiation injury prevention. (Japan)

55459 REVISION OF THE LAWS AND REGULATIONS CONCERNING INDEMNITY FOR DAMAGE DUE TO ATOMIC ENERGY AND ATTENDANT REVISION OF ATOMIC ENERGY INSURANCE. Hokaku, Nobuyoshi (Nippon Fire and Marine Insurance Co. Ltd., Tokyo). FAPIG (Tokyo); No. 63, 169-72(Nov 1971).

The system of indemnity for damage due to atomic energy in Japan consists of two laws, the law concerning the indemnity for damage due to atomic energy and the law concerning compensation contract in the indemnity for damage due to atomic energy. Since the establishment of this system in 1961, more than nine years have elapsed. Conspicuous development has been achieved in the field of atomic energy during that period, and various problems to be examined arose on the content and administration of this system. Also, international treaties were adopted in order to unify the indemnity system. The Japanese government established a special committee for the examination of the indemnity system for damage due to atomic energy in 1969, and the examination was carried out. As a result, a revision of the laws was enforced in Oct. 1971. The gist of the idemnity system lies in faultless responsibility of and concentration of the responsibility on atomic energy enterprises, compulsion of indemnity measures for the damage, and aid by the government. Main items of the revision are limitation of right demanding compensation of the atomic energy enterprises, raise of indemnity amount for the damage, treatment at the time of nuclear fuel transportation between atomic energy enterprises, and treatment of nuclear ships. Revision of atomic energy insurances was minimized because of a small revision of the laws. It was enforced on Oct. 1, 1971. The revised insurances are indemnity responsibility insurance in atomic energy facilities, indemnity responsibility insurance in atomic energy transportation, and atomic energy property insurance. A newly established insurance is indemnity responsibility insurance for damage of nuclear ship operators. (Japan)

Miscellaneous

55460 (ACRH–1000-349) TRAINING OF MEDICAL PHYSICISTS: SOME EXISTING TRAINING SCHEMES. Lanzl, Lawrence H. (Argonne Cancer Research Hospital, Chicago, Ill.). [nd]. 3p. (CONF-720435–4). Dep. NTIS.
From Seminar on training and education in medical physics; Kiel, Germany (10 Apr 1972).

55461 (ACRH–1000-350) MEDICAL PHYSICS IN THE UNITED STATES. Lanzl, Lawrence H. (Argonne Cancer Research Hospital, Chicago, Ill.). [nd]. 10p. (CONF-720435–5). Dep. NTIS.
From Seminar on training and education in medical physics; Kiel, Germany (10 Apr 1972).

55462 (AECL–3957) PLANT ASSOCIATIONS IN THE WHITESHELL NUCLEAR RESEARCH ESTABLISHMENT CONTROLLED AREA. Dugle, Janet R. (Atomic Energy of Canada Ltd., Pinawa (Manitoba). Whiteshell Nuclear Research Establishment). Apr 1972. 77p. Dep. NTIS (U. S. Sales Only). AECL $2.00.

55463 (AECL–4208) SURFACE FLATNESS MEASUREMENT BY BROAD SOURCE INTERFERENCE: RELATED TO MECHANICAL FACE SEALS. Metcalfe, R. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). May 1972. 20p. Dep. NTIS (U. S. Sales Only). AECL $0.50.

55464 (AERE-R–6601) PARALLEL ORGANISATION OF CAMAC PROCESSES. Lewis, A. (Atomic Energy Research Establishment, Harwell (England)). Jan 1971. 11p. Dep. NTIS (U. S. Sales Only). UK 13 pence.

55465 (AERE-R–6623) TECHNIQUE FOR HANDLING DATA BUFFERS IN REAL-TIME ON-LINE COMPUTER SYSTEMS. Lewis, A. (Atomic Energy Research Establishment, Harwell (England)). Dec 1970. 6p. Dep. NTIS (U. S. Sales Only). UK 1s. 9d.

55466 (ANL–7858) MODELING THE VISUAL PATHWAY FOR INTERACTIVE DIAGNOSIS OF VISUAL FIELDS. Goldbogen, Geof; Shelman, C. B. (Argonne National Lab., Ill.). Aug 1972. Contract W-31-109-Eng-38. 74p. Dep. NTIS.

55467 (ANL/ES–15) TRANSPORTATION AIR POLLUTANT EMISSIONS HANDBOOK. Wolsko, T. D.; Matthies, M. T.; Wendell, R. E. (Argonne National Lab., Ill.). Jul 1972. Contract W-31-109-eng-38. 187p. Dep. NTIS.

55468 (AREAEE–136) SEMICLASSICAL THEORY OF ELECTROMAGNETIC FIELD INTERACTION WITH A MANY-LEVEL MOLECULAR SYSTEM. Demchenko, V. V.; El-Siragy, N. M.; Hussein, A. M. (Atomic Energy Establishment, Cairo (Egypt). Dept. of Accelerators and Plasma Physics Research). 1972. 38p. Dep. NTIS (U. S. Sales Only).

55469 (BDX–613-382(Rev.)) FABRICATION OF MULTILAYER PRINTED WIRING BOARDS. Wilson, M. L. (Bendix Corp., Kansas City, Mo.). Sep 1972. Contract AT(29-1)-613. 68p. Dep. NTIS.

55470 (BDX–613-518(Rev.)) PROCESSING EVALUATION OF MAGNETIC PRODUCTS. Final Report. Moyle, W. F. (Bendix Corp., Kansas City, Mo.). Sep 1972. Contract AT(29-1)-613. 81p. Dep. NTIS.

55471 (BLG–461) INDEX OF S.C.K./C.E.N. PAPERS ISSUED IN 1970. (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)). [nd]. 52p. (In several languages). Dep. NTIS (U. S. Sales Only).

55472 (BMBW-FBK–72-9) STEROID GLUCURONYLTRANSFERASES. Rao, G. S.; Rao, M. L.; Breuer, H. (Bonn Univ. (West Germany). Institut fuer Klinische Biochemie). Jul 1972. 69p. (In German). Dep. NTIS (U. S. Sales Only).

55473 (BNL–16609) CONCRETE-POLYMER COMPOSITE MATERIALS DEVELOPMENT. Steinberg, Meyer (Brookhaven National Lab., Upton, N. Y.). Feb 1972. 18p. CONF-720832–3). Dep. NTIS.
From 3rd inter-American conference on materials technology; Rio de Janeiro, Brazil (14 Aug 1972).

55474 (BNL–17004) INTESTINAL BARRIER TO BACTERIAL INVASION. Hess, M. W.; Cottier, H.; Sordat, B. (Bern Univ. (Switzerland). Pathologisches Institut); Joel, D. D.; Chanana, A. D. (Brookhaven National Lab., Upton, N. Y.). 1972. 6p. (CONF-720645–1). Dep. NTIS.
From Conference on a re-examination of non-specific factors influencing host resistance; Bern, Switzerland (19 Jun 1972).

55475 (BNL–17110) CERTAIN INVARIANCE AND CONVERGENCE PROPERTIES OF THE PADE APPROXIMANT. Baker, George A. Jr. (Cornell Univ., Ithaca, N. Y. (USA). Baker Lab. of Chemistry. Brookhaven National Lab., Upton, N. Y.). 1972. 13p. (CONF-720626–2). Dep. NTIS.
From International conference on Pade approximants, continued fraction and related topics; Boulder, CO. (22 Jun 1972).

55476 (BNL–17115) PROGRAM IRT. Cullen, Dermott E. (Brookhaven National Lab., Upton, N. Y.). Jul 1972. 74p. Dep. NTIS.

55477 (BNL–50345) CALCIUM HOMEOSTASIS: THE HARD FACTS ABOUT SOFT BONES. Cohn, Stanton H. (Brookhaven National Lab., Upton, N. Y.). 15 Mar 1972. Contract AT(30-1)-16. 15p. Dep. NTIS.

55478 (BNWL–1605) CLIMATOGRAPHY OF THE HANFORD AREA. Stone, W. A.; Jenne, D. E.; Thorp, J. M. (Battelle Pacific Northwest Labs., Richland, Wash.). Jun 1972. Contract AT(45-1)-1830. 269p. Dep. NTIS.

55479 (BNWL-SA–4385) TECHNIQUES FOR THE CHARACTERIZATION OF SUSPENDED SEDIMENT AND SELECTED APPLICATIONS FOR THE ACQUIRED DATA. Routson, R. C.; Wildung, R. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). 1972. 18p. (CONF-720825–1). Dep. NTIS.
From fifth Summer meeting of Highway Research Board; Madison, WI. (2 Aug 1972).

55480 (BNWL-tr–72) CARBON ACTIVITY AND SOLUBILITY IN A STAINLESS CHROMIUM–NICKEL STEEL WITH ABOUT 18 PERCENT Cr AND 9 PERCENT Ni. Tuma, Hanus; Groebner, Pavel; Loebl, Karel. Translated for Battelle Pacific Northwest Labs., Richland, Wash., from Arch. Eisenhuettenw.; 40: No. 9, 727-31(1969). 14p. Dep. NTIS.

55481 (BNWL-tr–73) CARBON ACTIVITY AND SOLUBILITY IN AUSTENITIC CHROMIUM–NICKEL STEELS WITH ABOUT 18 PERCENT Cr. Tuma, Hanus; Vyklicky, Miloslav; Loebl, Karel. Translated for Battelle Pacific Northwest Labs., Richland, Wash., from Arch. Eisenhuettenw.; 41: No. 10, 98-3(1970). 14p. Dep. NTIS.

55482 (CEA-CONF–2000) APPLICATIONS OF THE SWEEPING MICROSCOPE TO SEMICONDUCTORS. Bresse, J. F. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Jun 1971. 3p. (In French). (CONF-710730–1). Dep. NTIS (U. S. Sales Only).
From Conference on microprobe of the National Association on Research Technique; Strasbourg, France (3 Jul 1971).

55483 (CONF-720642–1) QUALITY IMPROVEMENT IN PLANTAINS BY SELECTION. Cuevas-Ruiz, Jose; Koo, Francis K. S. (Puerto Rico Nuclear Center, Mayaguez). 1971. 7p. Dep. NTIS.
From tenth annual meeting of the Caribbean Food Crops Society; Mayaguez, Puerto Rico (11 Jun 1972).

55484 (CONF-720925–3) TECHNOLOGY AND ECONOMICS OF UTILITY TUNNELS AND COMMON TRENCHING. Boegly, W. J. Jr.; Griffith, W. L. (Oak Ridge National Lab., Tenn.). [nd]. 18p. Dep. NTIS.
From seventh intersociety energy conversion engineering conference; San Diego, CA. (25 Sep 1972).

55485 (COO–908-37) PHOTOTAXIS IN EUGLENA: BIOCHEMICAL ASPECTS. Tollin, Gordon (Arizona Univ., Tucson. Dept. of Chemistry). [nd]. Contract AT(11-1)-908. 37p. Dep. NTIS.

55486 (COO–1400-41) RESOLVING THE ENIGMA OF MULTIPLE MUTANT SECTORS IN STAMEN HAIRS OF TRADESCANTIA. Mericle, L. W.; Mericle, R. P. (Michigan State Univ., East Lansing). 1972. 13p. Dep. NTIS.

55487 (COO–1437-8) STUDY OF MATHEMATICAL MODELS OF MUTATION AND SELECTION IN MULTI-LOCUS SYSTEMS. Annual Progress Report, December 1, 1971–November 30, 1972. Lewontin, R. C.; Slatkin, Montgomery (Chicago Univ., Ill. (USA). Dept. of Theoretical Biology). 1972. Contract AT(11-1)-1437. 6p. Dep. NTIS.

55488 (COO–1469-208) COMPUTER SYSTEMS RESEARCH. Annual Report, September 1, 1971–August 31, 1972. (Illinois Univ., Urbana. Dept. of Computer Science). 31 Aug 1972. 84p. Dep. NTIS.

55489 (COO-1469-210) PERSPECTIVE TRANSFORMER FOR THE STEREOMATRIX 3-D DISPLAY SYSTEM. Verma, Shiv Prakash (Illinois Univ., Urbana. Dept. of Computer Science). Oct 1972. Contract AT(11-1)-1469. 77p. (UIUCDCS-R-72-532). Dep. NTIS.

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4 drawings.

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